# ENGINEERING NEWS
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TABLE OF CONTENTS:


ENGINEERING NEWS OF THE WEEK..... 113
A Large Roundhouse at Clinton, Ia.; Chicago & Northwestern Ry. (illustrated)..... 114
Municipal Improvements at Birmingham, Ala..... 114
Controlling a Topographical Survey (illustrated).... 115
1,000-HP. Compound Engine at the Paris Exposition (with full-page plate and other illustrations)..... 117
Tapping a Lake in France 60 Ft. Below the Surface. 117
Sea-Going Hydraulic Dredges for the East Channel Improvement; New York Harbor (with full-page plate and other illustrations)..... 118
The Laying Out of Rifle Ranges (illustrated)..... 119
Notes on Two Small Southern Water-Works Plants. 119
Metal Sheet Piling for Foundations and Coffer Dams (illustrated) ..... 122
Accurate Geodetic Work with a Small Transit..... 122
A Curious Result of Fire on Timber Roof Trusses (illustrated) ..... 123
Book Reviews ..... 123
Proposed Water Pollution Legislation in Indiana.... 123
The Utilization of Garbage-Furnace Heat at one of the Chicago Electric Light Plants (illustrated).... 124
A Co-operative Telephone System at Grand Rapids, Wis..... 124
New Sulphur Deposits in Russia ..... 125
A Quick-Acting Pneumatic Rock Drill (illustrated). 125
The Testing of Winding Ropes in the Province of Anhalt, Germany ..... 125
Wooden Lagging for Engine Flywheels (illustrated). 126
Low-Level Concrete Bridge Over the Mary River; Maryborough, Queensland (illustrated) ..... 126
EDITORIAL NOTES ..... 120
The Proposed Steel Consolidation—The Waning Prospects for Isthmian Canal Legislation at the Present Session of Congress—Pending Water Pollution Legislation in Indiana.
EDITORIAL:
Some Financial, Political and Sanitary Phases of Garbage Disposal..... 120
LETTERS TO THE EDITOR .....121, 122
Middle Ordinates in Inches for 20 and 25 Meter Chords—Co-operation Among Engineering Societies—The Competency of Correspondence School Graduates—The Safety of Shell Boilers—Notes and Queries.


THE NEW WHITE STAR STEAMER "CELTIC," which is now being built at Belfast, Ireland, has the following dimensions: Length, 680.9 ft.; beam, 75 ft.; depth, 44.1 ft.; gross tonnage, 20,880; net tonnage, 13,650. The old "Celtic," which this vessel replaces, had a gross tonnage of only 3,867. The new ship is not intended for speed; but she will carry 1,700 steerage passengers in 2, 4 and 6-berth staterooms, each stateroom provided with the necessary conveniences. As compared with length, the beam of the "Celtic" is the greatest of any merchant ship afloat; and her displacement is 33,000 tons, as compared with the 28,500 tons of the "Oceanic" of the same line.

THE AMERICAN SHIPBUILDING INDUSTRY, as to its economic conditions and its relation to foreign trade, is discussed in a late document issued by the Treasury Bureau of Statistics. Historically, it finds that the use of ironclads in our Civil War sounded the doom of wooden ships, for war and commerce, and the maritime ascendency was turned over to the iron-producing nations, of which Great Britain was then the leader. But with the present ascendency of the United States in iron and steel production, taken together with our late great increase in ocean responsibility, both commercially and politically, the Bureau believes that shipbuilding conditions have radically changed in our favor. The difference in the labor cost of production in foreign and American yards is conceded to be about 25% greater in the hull and 50% greater on the machinery in American yards; but this difference may be met by greater advance in the methods of construction, by piece-work methods of labor and by the standardizing of types and parts of ships. The consolidation of plants on the Lakes has already been productive of economies in developing uniformity in type of construction, and the connection of shipbuilding plants with steel-making establishments may still further reduce the cost of production. As showing the financial interests involved and the prospective profit of increasing the volume of the American merchant marine, the Bureau points out that for the fiscal year ending June 30, 1900, our imports and exports by sea aggregated $2,089,528,666 in value; yet only 9.3% of this value was carried in American ships.

A REPORT ON THE GALVESTON JETTIES and main channel, as these were effected by the storm of Sept. 8, 1900, has been transmitted to the Secretary of War by Gen. Wilson, Chief of Engineers, U. S. A. The board appointed included Col. Henry M. Robert, Major Henry M. Adams, Capt. Charles S. Riche and Capt. Edgar Jadwin, all of the Engineer Corps, U. S. A. This board reported, that in general the tide of Sept. 8 rose 16 ft. above mean low water, accompanied by a wind having a velocity of 100 miles per hour, and the barometer fell to 28.53 ins. Over 5,000 people perished, and the buildings were practically annihilated along the entire water front of the city and for a width of from two to six blocks. The board found that the mid-channel depth in the main ship channel was nearly 26 ft., the same as before the storm, with one small shoal formed. In general the jetties satisfactorily protected this channel, but they were damaged in many places. The maximum breach is 720 ft. long with a maximum depth below low water of 6.4 ft. The board recommends a capping of granite blocks to bring the jetties to the original constructed height; for the north jetty this would require 5 ft. above mean low tide, with 10 to 12-ton granite blocks used. The south jetty, for 16,000 ft. from its inner end, would have to be raised 6 ft. above mean low tide, and 5 to 6-ton granite blocks should be used; for the remainder of this jetty the height of wall and weight of blocks should be the same as for the north jetty. The estimated cost of this work is $1,500,000.

MINERAL EXPORTS OF THE UNITED STATES, in 1900, and including gold and silver, amounted to $436,227,477, or 28% of the total export of domestic products. The U. S. Bureau of Statistics classifies this mineral export as follows: Iron and steel, $130,000,000; mineral oils, $75,000,000; copper, nearly $60,000,000; coal and coke, over $22,000,000; paraffine, over $8,000,000; phosphates, over $5,000,000; gold production, $52,787,523; silver, $59,272,868. The iron and steel export of 1900 was nearly five times that of 1890, and all the others are greatly in excess of the figures of a decade ago. In 1890 the total export of minerals, metals and the important manufactures thereof amounted to $140,447,104; in 1900 these figures were $436,227,457.

ALASKAN COAL MINES are being developed at Homer, Western Alaska, by the Cook Inlet Coal Fields Co. A six-mile railway has been built from the harbor to the mines, and a shaft has been sunk tapping a 17-ft. coal vein at a depth of 100 ft. A large dock has also been constructed, and regular shipments of coal have been made to Juneau and other ports. This coal is reported as being a fine quality of lignite, burning with little soot and ash and good for steaming purposes. It is delivered at Juneau for less than $7.50 per ton. At Rock Creek, 20 miles from Dawson, the Alaska Exploration Co. is developing another coal mine. This coal is found frozen solid to a depth of 300 ft., and this frozen moisture is a detriment as there is considerable waste in driving out the frost. If large heating furnaces can be economically operated for getting rid of this frost, the coal will make a good fuel.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of the fast passenger train known as the Chicago Limited on the Erie R. R. near Greenville, Pa., on Feb. 7. Six persons were killed and a number were injured. The cause of the derailment is not known certainly, but is thought to have been either a broken flange or a broken rail.

A DYNAMITE EXPLOSION in the San Andres silver mine, situated in the Sierra Madres, Durango, Mexico, which occurred on Feb. 7, caused the death of 87 persons and injured a number of others. The dynamite was stored in one of the chambers of the mine and its explosion tore away the whole top of the mountain upon which the miners' village was located. The cause of the explosion is supposed to have been the crossing of electric wires which passed through the chamber.

A CIVIL SERVICE EXAMINATION for a hydrographer will be held Feb. 19 at the offices of the Municipal Civil Service Commission of New York city. The subjects of examination will be: Technical paper, experience, arithmetic and handwriting.

ELECTROLYSIS OF WATER MAINS at Dayton, O., is reported to have reached such a state that Mr. Chas. E. Rowe, Secretary of the Water Board, has requested the fire department to use the steam fire engines whenever possible and not to call for fire pressure from the water-works pumping station unless absolutely necessary.

THE CINCINNATI PUMPING ENGINE CONTRACT has been awarded to the Camden Iron Works, of Philadelphia, for $817,000. There will be four 30,000,000-gallon pumps for the new works at California, described in our issues of Dec. 8, 1898, and April 26, 1900.

MUNICIPAL OWNERSHIP OF WATER-WORKS at Denver, Colo., has received a setback in the nature of an injunction against an issue of $4,700,000 of bonds for the purchase or construction of works. While the injunction is only preliminary the opinion of the court is of such a nature as to ensure a final injunction, unless an appeal is taken. The case was tried in a U. S. District Court. The judge held the proposed bond issue illegal because it was voted at a special election; because the people voted on two contrary propositions, to buy or to build; and because the city made a 20-year contract for water with the Denver Union Water Co. in 1890. The contract was not exclusive and the judge even intimates that possibly the city might allow a second company to build works, even though he holds that the city itself cannot do so.

BIDS FOR GARBAGE COLLECTION AND DISPOSAL at Detroit, Mich., are to be received on March 11, as stated in our proposal columns. The city wishes "to ascertain in what manner and for what term (of years—Ed.) the most favorable contracts can be made." Accordingly it invites bids for contracts running 3, 5, 7 and 10 years, from July 1, 1901; for collection alone, for disposal alone, and for both collection and disposal. The disposal plant must be located at least two miles beyond the city limits. The garbage is now treated in a reduction plant by the Detroit Sanitary Works. Mr. F. A. Blades is Controller of Detroit.

A THREE-PHASE ELECTRICAL EQUIPMENT for the Metropolitan District Underground Railway of London is being considered. When bids were asked for recently the lowest offer was made by Messrs. Ganz & Co., of Budapest, who have equipped several three-phase railways on the Continent. Sir William Preece and Mr. P. Parker have been sent to Budapest to report upon the system which has been developed by Ganz & Co. They use 3,000 volts on the overhead wires along the track. In starting the two induction motors are placed in series or concatenation; that is, the secondary of one motor furnishes current for the primary of the second. If it is desired to stop the train when running at full speed, the motors may be placed in this relation and they will then return energy to the line until the speed falls to one-half.

THE MURPHY THIRD-RAIL SYSTEM has been installed upon a portion of the track in the Baltimore tunnel of the Baltimore & Ohio R. R. This system, in which only a short length of the conducting rail under the locomotive or car is live at any time, has been in use for some years at Manhattan Beach, N. Y., but this is the first time that it has been tried upon a road carrying a heavy traffic. The electric locomotives at Baltimore are equipped with four 300-HP. motors and are undoubtedly the heaviest in the world, and it was the trouble experienced in collecting by an overhead trolley system the very large currents necessary for their operation that caused the officials of the road to consider the use of some system of safety third rail. The magnetic switches which control the current upon the sections of the third rail have a capacity of 2,000 amperes each. A novel feature has been introduced to do away with the necessity for the storage battery which furnishes the current required to "pick up" the current when first starting the motors. The air compressor is so arranged that it may run as an engine receiving air from the compressed air tanks and driving its electric motor as a generator. We hope to give a more extended description of this installation in a future issue.

A MEXICAN RAILWAY CONCESSION is offered for public bids by President Diaz. The railway line would connect Matamoras with Monterey; and the subvention that may be granted must not exceed $5,000 per kilometer, or about $8,000 per mile, and must not be greater than $1,000,000 in all. The air-line distance between the points named is about 200 miles, with no great engineering obstacles to overcome.

THE ST. LOUIS WORLD'S FAIR, intended to celebate the centennial of the Louisiana Purchase, has made a beginning by the passage of an ordinance by the City of St. Louis authorizing the issue of $5,000,000 in bonds for this purpose, at 3¼% interest. This action was taken owing to the refusal of Congress to consider an appropriation of $5,000,000 in aid of such a fair until the City of St Louis had passed an ordinance appropriating an equal sum. Prominent citizens at the same time signed a guarantee bond of $1,000,000, assuring earnings to the city, and devoting the accrued fund for the construction of a city hospital. According to a late Washington item the Congressional committee having this matter in charge has decided to report favorably upon the appropriation asked for.

THE PREVENTION OF HAIL STORMS by acetylene explosions is to be undertaken by Maggiora & Bianchi, of Italy, who have invented a "cannon" for this purpose. This instrument is favorably noticed by the French delegates to the Padua Congress, of November, 1900, which was held to consider the question "of firing cannon at clouds to prevent hail." The device includes a generator of acetylene gas, a tube, or "cannon" pointing upward, and a device for electrically firing the gas. It is proposed to arrange these in groups of 50, all connected by wires, and the generator is charged with 65 lbs. of carbide of calcium, sufficient for 1,000 shots, or 6 months' service. No experiments are reported; but the inventors will undertake, this year, to protect grape growers against damage by hail, "for a comparatively small sum." This report is sent in by John C. Covert, U. S. Consul at Lyons, France, and will recall to American readers the palmy days of Cloud-Compelling Dyrenforth and his successors who bombarded the skies of Kansas and Nebraska a half a dozen years ago to produce rain "for a comparatively small sum."

## A LARGE ROUNDHOUSE AT CLINTON, IA.; CHICAGO & NORTHWESTERN RY.

The new roundhouse of the Chicago & Northwestern Ry., at its divisional point at Clinton, Ia., is of somewhat exceptional size and design, and has some auxiliary equipment of special interest. Until last year, the engines of the Iowa and Galena divisions were housed in a roundhouse built in 1865, which only contained 25 stalls. Nearly 80 engines have to be taken care of at this point, and when 40 or 50 engines were there at one time (as often happened), it became necessary for several to stand outside. Besides this, the length of engines had increased to such an extent that it became necessary two years ago to lengthen the house by putting on a vestibule, so that one of the large freight engines of the class "R" type could be got inside and the doors closed behind it. This, in the winter time, was a great improvement over the open doors, but the place was altogether too crowded for the work to be done satisfactorily. It was, therefore, decided to build a new house, and a suitable site was located between Camanche Ave. and the freight yards. Ground was broken Aug. 14, 1899; and the building was occupied on May 14, 1900. The work was done under the direction of Mr. W. D. Walden, Superintendent of Bridges and Buildings, and took only nine months.

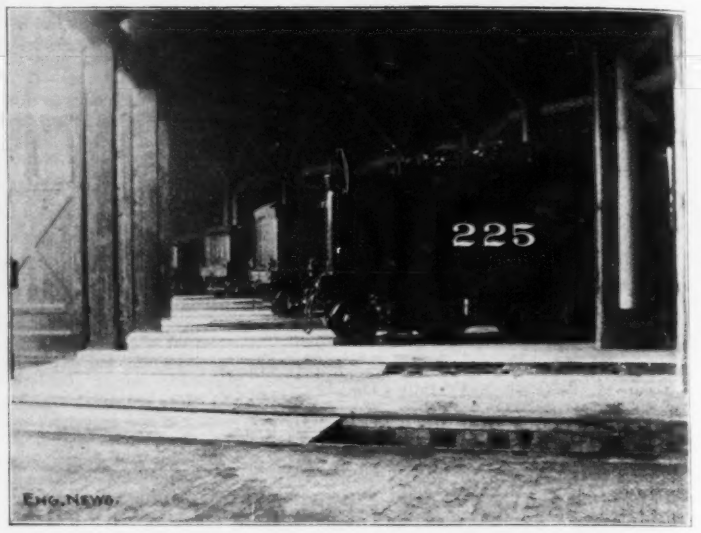
Fig. 1.—Central View of Roundhouse at Clinton, Ia.; C. & N. W. Ry.

The building, Fig. 1, is a complete circle, and has 50 radial tracks; 48 of these are engine stalls, and the others are for entrance and exit. The radius of the outside wall is 187 ft. 6 ins.; radius of inside wall, 106 ft.; clearance inside walls, or width of house, 81 ft. 6 ins. The length of the longest engine and tender is 62 ft. 8½ ins., so that ample clearance is given, with allowance for a further increase in length of engines. This is shown by the views in Fig. 2, with one of the largest engines in the house. The pits are 51 ft. long, with the heads 14 ft. 6 ins. from the outer wall. They are lined with rubble masonry, and are 2 ft. 6 ins. deep at the outer end and 3 ft at the inner end. Drop pits for engine and truck wheels are excavated from the solid rock and fitted with drop-pit jacks. The outer wall is of brick, 17 ins. thick. The inner wall has cast-iron columns 13 ft. c. to c. and 17 ft. high. These carry a double line of 10-in. I-beams supporting the upper part of the wall, which is of brick. The rectangular entrances, 13 × 17 ft., are each closed by double swinging doors. The roof has timber beams supported by timber posts at the walls and two intermediate points. The 3-in. plank sheathing has a slope of ¾-in. per ft. to the outer wall and is covered with gravel. The clear headway is 23 ft. 9 ins. at the inner wall and 18 ft. 9 ins. at the outer wall. Over the outer end of each stall is a cast-iron drop smokejack. The floor is of brick laid on edge. Wood paving is good while it lasts, but being kept damp by the washing out of boilers it soon decays. The turntable is 70 ft. diameter. It is built on a rock foundation and will be operated by electric motors. A circular space 103 ft. 6 ins. wide lies between the table and the house.

Close to the roundhouse is a machine shop and storeroom, 60 × 140 ft. The machine shop equipment includes one 28-in. and one 16-in. screw-cutting lathe; a planing machine 30 × 30 ins., 9 ft. long; a 21-in. crank shaping machine; a 30-in. swing drill press and a bolt-cutting machine cutting sizes from ⅝-in. to 1½ ins. This building and the roundhouse are heated by the Sturtevant hot-air system, the heating apparatus being installed in a room between the walls of the two buildings. The oil house is a fireproof building, 33 × 35 ft. The 12 oil tanks are underground, and the oil is raised to convenient faucets by compressed air. For handling the great amount of ashes from the two ashpits, a special plant was devised by Mr. Geo. R. Henderson, Assistant Superintendent of Motive Power and Machinery. Drop-bottom iron buckets are used, running on inclined tracks at right angles to the ashpit, and operated by compressed air hoists at each pit. There are four of these buckets, which receive the ashes dumped from the engines. When hauled up the incline they are over a track for an ash car, into which the contents are discharged by means of a dumping device.

The water supply of the plant is obtained from an artesian well 1,175 ft. deep. It is pumped to an elevated wooden tank by a duplex pump, 14 × 12 × 14 ins.; a smaller duplex pump, 12 × 8 × 12 ins., is used for washing out boilers, with a nozzle pressure of 100 lbs. per sq. in. A sand-house, coaling station with 24 pockets, water columns, and cinder-pit hydrants are provided. A 14-in. water main passes through the yard, with 3-in. branches to the hydrants. There is also a 24-in. pipe sewer, with a 12-in. branch leading to the 6-in. drain from the turntable pit. A spur track runs directly to the machine shop and storeho[use] and there are two tracks entering the roundho[use].

For information and photographs we are [in]debted to Mr. Robert Quayle, Superintendent Motive Power and Machinery, C. & N. W. R[y.] and to Mr. H. T. Bentley, Master Mechanic of the Iowa Division, at Clinton, Ia.




View at Outer Side. View at Inner Side.

FIG. 2.—INTERIOR VIEWS OF ROUNDHOUSE (SHOWING CLEARANCE WITH LONGEST ENGINES).

## MUNICIPAL IMPROVEMENTS AT BIRMINGHAM, AL[A.]

Like so many other American cities, Birmingham, Ala., cannot be judged properly, as a business center, without considering the surrounding towns. While this thriving Southern city shows a population of only 38,415 by the census of 19[00] (against 26,178 in 1890) the nearby towns whose interests are closely allied with it bring up the total for the section to the vicinity of 100,000, according to local figures.

The city has a very democratic form of representative government, consisting of a mayor and 18 aldermen, with no second house. The mayor presides at all meetings of the aldermen, must vote first on all questions, and has no veto power. To use a local description, he "is just an elevated alderman." There is no board of public works, but there are street and sewer committees composed of aldermen. The city engineer is appointed yearly by the aldermen, and is allowed to choose his own assistants. Mr. Julian Kendrick has been city engineer continuously for nearly ten years, and has been appointed for another year. The city charter provides for a city engineer, but prescribes no duties. Some of the laws authorizing public improvements require that the city engineer shall do certain things. When the aldermen pass a resolution for a piece of work the city engineer not only prepares the plans and specifications, but usually draws the necessary ordinance, subject to the approval of the city attor-

Fig. 3.—Ash Handling Plant at Clinton, Ia.; C. & N. W. Ry.

ney. For the past ten years the city engineer has inspected all plumbing work, first passing on plans for the same. Before that, local plumbers had the matter in charge, nominating the inspector, which method proved to be unsatisfactory.

After many attempts, Birmingham recently succeeded in securing an amendment to the State constitution of Alabama, which permits it to levy a tax of 1% on real and personal property, instead of 0.5% as formerly, for all expenses other than street and sewer improvements. The amendment applies to Birmingham, only, and was defeated many times before it was finally carried, because it required a majority of all the votes cast throughout the State, and the people outside of Birmingham, having no interest in the matter, failed to vote for it. The total cost of sewers and paving is assessed on abutting property, or in the case of trunk sewers on the sewerage district. Street intersections are assessed one-half block in each direction. The assessments are payable in ten annual installments, if time is desired.

The sewers of Birmingham are on the separate plan, the sanitary sewers being in 20-ft. alleys. They discharge into a small stream, about two miles below the city. Of the numerous towns in this center, Birmingham and Bessemer are the only ones having sewerage systems. The several towns are located in two rather narrow valleys, each having only a small stream flowing into it, and with no water near by sufficient to receive the sewage without previous treatment. In the fall of 1900, Mr. Kendrick made a report to the county board of revenue, in which he recommended the formation of a joint sewerage district, with a trunk sewer in each valley and purification works at the lower end of each outlet. Since then a bill has been introduced in the legislature, providing for the construction of county trunk sewers and purification works. The work is to be done under the direction of a committee of nine citizens, named in the bill, who serve without pay and choose their own successors. The committee also has power to abate the pollution of any stream in the county used as a source of public water supply. It is authorized to appoint such engineers as may be necessary to design and build the contemplated works.

Near the outlets of each of the proposed trunk sewers are coke ovens, and Mr. Kendrick recommended that two acres of coke filter beds be constructed at each outlet, and the results secured studied carefully for a year before the purification plants are fully decided on. Mr. Kendrick states that he was considering the possibility of turning the outlet sewers into septic tanks, for experimental purposes, as the flow of sewage would at first be small as compared with the capacity of the sewers, by providing gates at the lower end and at certain manholes, when the account of a similar plan at Los Angeles was published in Engineering News of Nov. 8, 1900.

Since the move for joint disposal works was started six towns in the county along the proposed trunk sewers have secured authority to issue bonds for sewerage purposes.

The Jefferson County Board of Revenue has built some 200 miles of chert macadam roads. Col. J. B. Jackson is the superintendent of these roads, which were built under different engineers.

Most of the improved streets of Birmingham are macadamized with chert, in addition to which there are some granite block and brick pavements. The granite is put down on slag or broken stone, compressed to a thickness of 8 ins., with a 16-ton roller. Brick is laid on 5 ins. of concrete. The finished macadam is composed of 4 ins. of chert, on 8 ins. of slag, rolled with a steam roller.

Brick pavements were first laid in Birmingham in 1900. On one street they are laid, for a short distance, on a 9.9% grade. The bricks on that grade have ½-in. rounded edges, instead of the ¼-in. used elsewhere. At Chattanooga, Tenn., brick have been used on grades up to 8¾%. In neither of these two cities is there often any ice on the pavements.

The brick used at Birmingham come from Coaldale and from Ensley, a few miles distant. A sand filler was used for the first brick put down, then a sand filler for one-half and a 1 to 1 Portland cement filler for the other half of the street, and finally a cement filler was adopted for the whole width of the street.

There is no systematic street cleaning in Birmingham. A chain gang is employed at times, and a dozen negro boys from 12 to 14 years old, some in chains, were seen at work the morning of the day the writer was in the city.

Garbage is collected by contract, hauled away and buried by the contractor. Ashes are kept pretty free from garbage, and are used to fill in vacant lots. The garbage contract has expired and is being extended from month to month, while the city is trying to decide whether or not it will do the work itself hereafter.

The garbage furnace used by the city for some years has been torn down. The fuel bill was too high. Mr. Kendrick stated that probably a new furnace will be erected as soon as it is demonstrated that there is one in existence that will do the work in an economical and otherwise satisfactory manner.

The city is now replacing its old public market and city hall with a new building, for which $200,000 has been appropriated.

The city owns a number of small parks, scattered through its area, perhaps five or six in all. They have not been given much care heretofore, but a little work is now being done on them. Nothing in the way of public baths or gymnasiums has been attempted.

The city suffers much from smoke, or at least outsiders not accustomed to it do, but it has not attempted any smoke prevention measures thus far, encouraging rather than discouraging smoke, as an evidence of growth and prosperity.

The health interests of the city are in the care of a county board of health, under which there are local sanitary inspectors, paid by the city. The inspectors look pretty carefully after foul backyards, "between frosts."

There is one gas company, one electric light and one street railway company. The electric light company supplies power to the street railway company and to commercial motors. The Consolidated Electric Light Co. has obtained permission to bury its wires, but has not begun to do so. Both the Southern Bell Telephone & Telegraph Co. and the People's Home Telephone Co. have their wires underground in the center of the city and the Southern Co. is extending its underground system.

## CONTROLLING A TOPOGRAPHICAL SURVEY.

By Wm. C. Bunnel, U. S. Junior Engineer.

A survey is made to obtain data from which estimates and computations for engineering works are made; and a topographical survey has for its object the location of natural and artificial features of a country as to position and elevation for the above purpose. As property increases in value more data must be secured; and often, as in the case of a river, the survey is quite extensive, and the best method of making it requires attention. Evidently, this method is the one which secures the desired degree of accuracy in the most rapid and simple manner and at least cost, and experience has shown the stadia method to be well adapted for this purpose.

All engineering works as a rule require a map of the country in which it is proposed to carry them out; especially is this true of the work done by the general government; its projects being of such magnitude and importance and requiring such minute detail that the stadia method of obtaining topography has been adopted, and it can also be advantageously employed by corporations and individuals requiring similar work. From a constructive point of view a map may be defined as a sketch controlled by locations; and the correctness of the map will depend primarily on the accuracy of these locations, and secondarily upon their number and distribution as well as on the correctness and fullness of the sketch.

Before choosing a method of control the object or utilization of the survey, time and means at command and desired results should be considered. The greatest accuracy in all cases is not always desirable, because it is not the most economical, and in the end may give no more desirable results than could have been obtained by a more judicious use of means and time. In any case arrange the means at hand to get the desired results in the end. Conditions both natural and imposed will also help to determine the method to be used.

While it is desired to discuss only one method, two other schemes may be briefly mentioned. A tertiary system of triangulation is probably the most accurate, as it is capable of more refinement, both in the field and in the reductions, than can be applied to either of the two following methods, and would probably be used in an extensive survey or where there is a wide river. Another method is one well adapted for surveys from a few miles up to about 300 miles in length; such as a survey of a belt of country for a railroad or canal; in fact, it fits the case where a survey is more or less of a preliminary nature to determine the feasibility of a proposed undertaking and where permanent marks are not to be established. Knowing in general the territory to be covered by a survey, a base line is run dividing it as near equally as possible; this line to have the degree of accuracy consistent with the object and means for making the survey. A high degree of accuracy may be secured by repeating the angles between the courses and applying some of the refinements of triangulation base line measurements to the courses. The azimuth of one course is obtained by an observation, and by means of angles it is determined for the others. These observations for azimuth should be made about every 8 or 10 miles and the convergence of meridians computed, and after allowing for this, the difference remaining between the azimuth carried to this second base and its observed azimuth must be taken as instrumental error. The convergence and instrumental error may then be distributed back among the courses; the former according to the departure of the respective courses, and the latter according to the number of courses. The co-ordinates of the stations are now computed and the elevations of the stations having been determined by a check line of levels, the topographical work can be controlled by this line as follows: After taking all the topography possible from this base, "stadia circuits" are started from it and run in any desired direction and distance up to five or six miles, as conditions may require, and again brought back and closed on this base. All elevations and distances of these stadia circuits are determined by stadia readings, and the closure on the base line shows the amount of error in elevation, azimuth and distance of these lines. If only a rough preliminary survey is required, the base might be measured in an ordinary manner and the azimuth carried directly on the instrument by means of back and fore-sights. The above method of measuring the angles and courses may seem to involve an unnecessary amount of work; but in making a great number of measurements which are continuous it should be remembered that extra precautions must be taken and more care used than in a single measurement; because some errors are accumulative, and it is necessary to guard against such errors as can exist in a great number of measurements but not in a single measurement.

The method to be described in detail is the following, which, with its easy and rapid means of adjustment, is well adapted for surveys of about 100 to 150 miles in length and about three miles in width: The adjustment is capable of dealing with any number of parties, but for an ordinary river survey probably three parties are all that would be required. This method does not require any of the preliminary work proposed in the first two; the topographical work starts at once, and for rapidity and economy and results obtained, it is certainly, under the conditions given below, a very desirable way of controlling a survey.

No better way of describing it can be given than taking an actual case carried out in the field. A preliminary survey of about 100 miles of river was required; the distance between bluffs averaging from ½ mile to about 3 miles. There was nothing along this river on which the survey could be checked, and it was carried out as follows: The work was divided between three parties—one taking the topography on the right bank, another performing a like duty on the left bank; and the third doing all between the tops of banks and also locating and taking all soundings.

*U. S. Engineer's office, 1657 Indiana Ave., Chicago, Ill.

A convenient base was laid out at the beginning of the work and the azimuth determined by a stellar observation; from the same point on this base the three parties started their respective lines; all starting with the observed azimuth of this base and carrying the azimuth of their lines on the instruments by means of back and foresights; and about every two miles, or whenever convenient, the parties compared azimuth by reading over a common course and noting any difference.

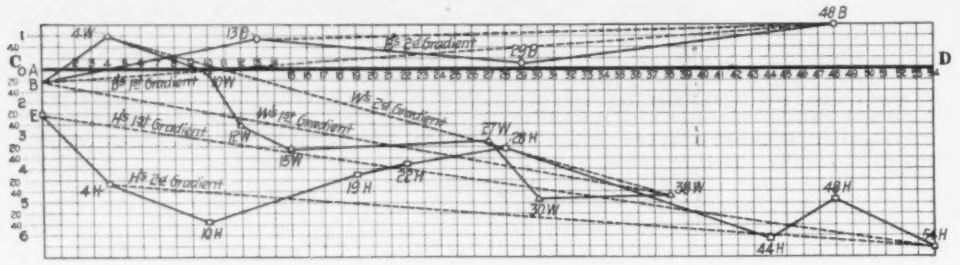
The courses on the banks were measured with a steel tape, using reasonable care, but no refinement as to temperature and tension. One line was single measured, while the other was a double-measured line, thus making a base line of it on which a final stand could be taken in case of any serious disagreement between the two lines. The elevations of all instrument stations were determind by a checked line of levels. At intervals of 8 or 10 miles new bases were laid out and new observations for azimuth taken, and all lines were closed up on these new bases. Again all parties started from the same point on this new base with its observed azimuth (all instrumental error and difference due to convergence having been dropped by changing to this new azimuth) and made comparisons as before.

It is a fact that needs no explanation that three observers with different grades of transits reading from 20″ to 1′ will, after traversing various kinds of country and with a different number of courses, fail to have the same azimuth at the comparison courses; these differences will in general be from 30″ to 5′. Since the three observers were supposed to use equal care and had equal advantages as to ground, rods, etc., and the transits being in first-class condition, the three lines were given equal weight as to azimuth. For instance, at Sta. 4, where observers H and W differ by 0° 04′ 30″, there was no reason to suppose that either H. or W. made this entire amount, but that each had a share in it.

The problem is to determine the instrumental error for each line and then to adjust the lines to get rid of it. The first step is to determine the difference between the observed azimuth of the second base and that carried to it from the first; but this will also contain the amount of convergence of meridians between bases; so, before the instrumental error can be determined, this convergence must be known, and it may be found as follows: The azimuth stations of two bases were called C and D, and the latitude of each is known either by an observation at each point or by an observation at one and computing the other from it; by using the mean of the equatorial and polar semi-diameters the average semi-diameter of the earth was obtained, with which the length of 1° of longitude was computed. Knowing this length, it is now desired to find the length of 1° at the latitudes of C and D. The mean of these latitudes being taken, which may be called average latitude; then—Length of 1° of longitude, at average latitude = length of 1° (computed longitude) × cos average latitude; and dividing the total departure of D from C by this length of 1° at average latitude, we get the difference of longitude of the two points, sometimes called meridian difference. We then apply the well-known formula for convergence; or convergence = X sin ½ (La + Le), X being the difference of longitude of the two points and La and Le being their latitudes.

In running in an easterly or westerly direction in the northern hemisphere a line always bears to the south as a result of this convergence of meridians. So that having run in a westerly direction from C to D, if we wish to know what azimuth we should have here, it is necessary to add the convergence existing between the respective meridians through C and D to the observed azimuth at D; which simply refers the azimuth to the meridian at C, and therefore gives the azimuth that should be obtained by the observers in running from C to D, provided there be no instrumental error. But evidently if there is any difference between the above it must be taken as the instrumental error for that run.

In the case at hand, the observed azimuth (from Polaris) of the base at D was 179° 00′ 54″, and the computed convergence was 0° 04′ 45″; hence the azimuth of base D, referred to the meridian at C, is equal to 179° 00′ 54″ plus 0° 04′ 45″ equals 179° 05′ 39″. By following the above argument we have the results of this run in the following table:




COMPARISON TABLE.

| Station. | Difference—Observed | Difference—Gradient. |
|---|---|---|
| No. 1. 4 H..... 4 W | H0° 04′ 30″ > W | 0° 00′ 55″ |
| No. 2. 10 H.....10 W | H0° 04′ 30″ > W | 0° 03′ 45″ |
| No. 3. 13 B.....10 W | W0° 01′ 00″ > B | 0° 00′ 05″ |
| No. 4. 13 B.....10 H | H0° 05′ 30″ > B | 0° 03′ 50″ |
| No. 5. 19 H.....12 W | H0° 01′ 30″ > W | 0° 04′ 30″ |
| No. 6. 22 H.....15 W | H0° 00′ 30″ > W | 0° 01′ 30″ |
| No. 7. 28 H.....29 B | H0° 02′ 30″ > B | 0° 04′ 25″ |
| No. 8. 44 H.....27 W | H0° 03′ 00″ > W | 0° 01′ 10″ |
| No. 9. 48 H.....30 W | H0° 00′ 00″ > W | 0° 02′ 35″ |

DIAGRAM OF GRAPHIC ADJUSTMENT OF LINES BETWEEN TWO BASES.

| No. of courses. | Azimuth—Observed azimuth at D. | Azimuth—At D, referred to C. | Azimuth—Carried to D by observers. | Instrument error. | Observers. |
|---|---|---|---|---|---|
| 48 | ..... | ..... | 179° 04′ 20″ | −0° 01′ 19″ | B |
| 38 | 179° 00′ 54″ | 179° 05′ 39″ | 179° 09′ 30″ | +0° 03′ 51″ | W |
| 54 | ..... | ..... | 179° 11′ 03″ | +0° 05′ 24″ | H |

With the above results the following graphic method, for eliminating instrumental error for each course between C and D may be used, the graphic being devised by Jas. A. Seddon, Asst. Engr.

First, azimuth has no relation to actual distance; it may be carried from point to point without any regard to the distance between points; so, by referring to the diagram it will be seen that three spaces horizontally were taken to represent a course and one space vertically as equal to 10″, and the heavy line the zero or line of no error. At first an approximate latitude of C was used, and later, after the lines were run, a true latitude was computed and the difference in azimuth of the base caused by using the different latitudes in the formula:

$$\text{sin of azimuth} = \frac{\text{sin of polar distance}}{\text{cos of latitude}} \text{ was } 23''$$

that is, the azimuth by which the courses were run was 23″ too large, hence it was necessary to reduce all courses by this constant amount, and this is why the lines were started at the point B 23″ below the zero line; otherwise they would have started at A. Observer H having started with an azimuth 1′ too large, is necessarily dropped down 1′ from B to E.

It appears that observer B had 48 courses between C and D, and from the above table his instrumental error was 0° 01′ 19″; hence at D, he will be 0° 01′ 19″ from the zero line on the positive side, as he came out too small. In a similar manner observers H and W, from the above table, will be located at 54 H and 38 W, respectively. The starting and ending points of each line being fixed absolutely by observation, all adjustment must be made between these two points: By connecting the starting points with the respective ending points we have gradients by which the instrumental error could be corrected by scaling the vertical distance between these gradients and the zero line, were it not for those local conditions of comparison of azimuth at different points; each of these being a problem in itself.

Take the first comparison between W and H at their respective stations 4. Here H has a larger azimuth by 0° 04′ 30″, and, as stated above, each line having equal weight, it is reasonable to suppose that each made an equal amount of error. This difference at this point is an absolute fact, i. e., it is something that actually exists in the lines up to this point, and which would not exist were the lines run with absolute accuracy; so that before a correction can be applied, W's and H's gradients must be changed to fulfill the above condition. These first gradients show a difference of 0° 00′ 55″ and the actual observed difference is 0° 04′ 30″, hence the amount that each gradient must be shifted is ½ [0° 04′ 30″ — 0° 00′ 55″] = 0° 01′ 47.5″. The gradient of W must be shifted in a positive direction to increase his azimuth, and that of H in a negative direction to decrease his azimuth, so as to satisfy the fact that there is a difference of 0° 04′ 30″ at this point. Then lines from which to scale corrections will now be from B to 4W, and E to 4H, and W's second gradient will now be 4W to 38W, and H's from 4H to 54H.

The next comparison was between W, H and B making a case where the three parties compared over a common course. The points to be adjusted are 10W, 10H and 13B, as follows. By referring to the diagram and table and comparing the above points, it is seen that by taking one-half of the difference between the respective observed and gradient differences (thus getting the least movement for each), the following movements are obtained:

| H and B. | H and W. | W and B. |
|---|---|---|
| h — 50″ | H — 22.5″ | W — 27.5″ |
| B + 50″ | W + 22.5″ | B + 27.5″ |

Therefore, H's movement is — 50″, B's + 50″ and W's + 22.5″ for H and — 27.5″ for B, making a sum movement of 50″ also, but actually only moving — 5″ from his gradient position. The remaining points are, of course, obtained in the same manner. By scaling the corrections at the comparison points and applying the results with the proper sign to the observer's azimuths should cause them to agree, and this can be used as a check on the work. Should one observer have a better instrument, or for some reason run a better line, then this line may be given any desired weight and his gradient shifted only enough to conform with this weight.

This adjustment brings all the lines down to the line of no error so far as instrumental error is concerned, and any failure of the co-ordinates to close may now be attributable to the element of distance. Starting with C as zero, the co-ordinates of the instrument stations between C and D are computed, and there will, without doubt, be a failure of closure at D on account of the error in chaining. But there is no absolute check for this, as the co-ordinates of D can only be known by computing from C, so the mean of the latitudes is taken for the latitude of D and the mean of the departures for the departure as they were determined by the two chained lines.

By taking the difference between these average latitudes and departures and the actual ones obtained by the observers, and dividing these differences by the total run of latitude and departure respectively, we can get the amount per 1,000 ft. to apply to the partials. In applying these corrections due regard must be given to signs; should the final total be positive and in excess of the average for D then the correction is negative; and in order to get this negative effect all minus quantities will have to be increased by this correction (for increasing the minus direction decreases the positive), and all positive quantities will be diminished by the correction. But in place of changing each partial

it is clear that only the totals need be changed, remembering to apply the correction progressively—that is, for each total apply the correction of the previous total plus the correction corresponding to the partial for this last total. These corrections for the partials will, when summed up in the end, equal the last correction to be applied to the last total, and evidently equals the difference between the observer's result and the average result.

It often happened that at these comparison courses the two chained lines were connected by a triangle, so the co-ordinates may be adjusted up to this point and from here to the end, or next triangulation point, in the same manner as above; remembering that the amount to be corrected for is the difference between the amount in the end and that at the triangulation point, and to still apply the total correction at the triangulation point plus the new partial corrections. Should there be reasons for it, one line may be given more weight than the other in determining these average co-ordinates.

Since the third line was made up entirely of stadia measurements, it was adjusted between the two chained lines at the several comparison points. This brings the final adjustment to D; now D can be assumed as zero and the above method repeated to the next observation station. In laying out the map, if only the result of a plane survey is desired, D is located from C and then the meridian through D is turned an amount equal to the convergence, and the lines from D plotted from this last meridian to the next observation station.

As there seems to be very little published information relating to the error likely to be caused by carrying azimuth directly on a transit, and also as to the error of ordinary chaining, the following is offered: For about 57 miles of line the instrument work gave an error of 1:11899; and for 115.6 miles of line the error of chaining was 1:5527. The above method has necessarily been described in detail, but the actual use of it is quite easy and rapid.

## 1,000-HP. COMPOUND ENGINE AT THE PARIS EXPOSITION.

(With full-page plate.)

In our issue of Aug. 2 we described a 1,500-HP. triple-expansion engine, built for the Vienna electric lighting central station, by the firm of Friederich Wannieck & Co., of Brünn, Austria. This firm, which has lately consolidated with the firm of H. A. Luz to form the Erste Brünner Maschinen-Fabriks-Gesellschaft, exhibited a 1,000-HP. compound engine at the Paris Exposition, which has been purchased by the Austrian Imperial and Royal War Department for the Imperial and Royal Powder Mill at Blumau.

This engine was designed to run at high speed and for that reason has been fitted with a special valve-gear, known as the Lentz patent gear. It is a horizontal cross-compound engine, and is directly coupled to a dynamo made by the firm of Ganz & Co., of Leobersdorf. The combined set is shown in Fig. 1.

The cylinders are 20.67 and 37.4 ins. in diameter, with a stroke of 35.43 ins. The normal speed is 125 revolutions per minute, but the engine can be speeded up to 138 revolutions. With 180 lbs. steam pressure and an expansion of 14 to 10 volumes it develops 800 to 1,000 net HP.

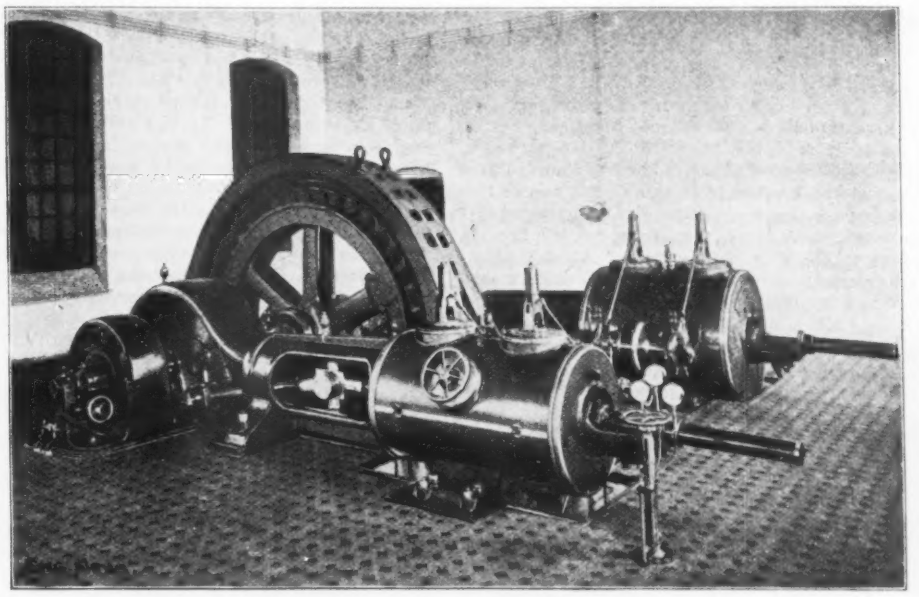
Each half of the engine is of the ordinary side-crank construction, the cylinders being firmly attached to the cross-head guides. To allow for the expansion of the frame the cylinders are mounted upon standards which are movable upon the sole plate. On the rear cylinder-heads are adjustable bearings for the tail rods. The main steam valve is on top of the cylinder and all pipe connections are underneath.

Both cylinders are fitted with the above mentioned Lentz valve-gear. The cut-off for the high-pressure cylinder is controlled by a centrifugal governor, whereas that of the low-pressure cylinder may be adjusted by hand. The spindles of the valves have no stuffing boxes, which would increase the friction on them, but are enclosed in boxes and lubricated by the oil-cups above them. The governor can be made to vary the number of revolutions by turning the hand-wheel fixed at the rear of the governor-shaft bearing.

The cranks are not set at 90° as usual, but the low-pressure engine is 120° in advance, which is claimed to give a better adjustment of the weights and more even running. The crank disks are of cast steel, with lead counterweights, and are forced onto the crank-shaft by hydraulic pressure. The crank disk is provided with a worm gearing for the starting gear. The armature of the dynamo, which is 13 ft. 5.4 ins. in diameter and weighs about 23 tons, forms the only fly-wheel.

The jet condenser is place beneath the floor. The double-acting air pump combined with a feed-pump, is worked from the crank pin on the low-pressure side. The steam cylinders, as well as the stuffing boxes of the high-pressure cylinder and the air pumps are lubricated by automatic oil pumps.

For the information and drawings here presented we are indebted to the builders of the engine, the Erste Brünner Maschinen-Fabriks-Gesellschaft, of Brünn, Austria.



A 1,000-HP. COMPOUND ENGINE, WITH LENTZ VALVE GEAR.
First Brünner Machine Manufacturing Company, Brünn, Austria, Builders.

## TAPPING A LAKE IN FRANCE 60 FT. BELOW THE WATER SURFACE.

A novel and interesting piece of engineering work is noted in "Le Genie Civil" for Jan. 12, 1901. This relates to an increase in stored water and in the dry weather flow in the canalization of the river Neste, a tributary of the river Garonde, not far from the Spanish border of France. Various small streams and lakes had already been utilized for this purpose; but the retrogradation of the glaciers of the Pyrenees brought about a decrease of the water available, and some other source had to be sought.

This source was found in the Lake of Caillaouas, situated in a bare and almost savage section of the country, without means of access and presenting engineering difficulties that at first seemed insurmountable. But work upon tapping this supply was commenced in 1891 and completed in 1898; and a storage reservoir was secured which added 6,600,000 cu. m. to the supply.

This lake was fed by the Glacier of Gours Blancs, and by small intermediate lakes. Its surface covered 106 acres and it was situated in a basin of solid granite dominated by high mountains. It was divided from the valley of one of the head streams of the River Neste by a granite ridge; and it was determined to pierce this ridge by a tunnel, which should be fitted with a dam and controlling valves.

This tunnel was 602 ft. long; and its bottom at the upper or lake end was located at a level sufficient to tap a layer of water 60 ft. deep. The tunnel section was a rectangle, 4.9 ft. wide by 5.6 ft. high, surmounted by the arc of a circle with 1-ft. rise. Its width was sufficient to permit two miners to work on the face; and while tunnel driving was commenced at first from the lower end, it was continued from a shaft sunk about 100 ft. from the border of the lake. At the foot of this shaft and above the crown of the tunnel a chamber was excavated for the better manipulation of the controlling valves that were later put in. This chamber was $22 \times 17$ ft. by 6.6 ft. high.

The driving of this tunnel required the work of 100 men, working day and night, for 342 working days. The greatest difficulty naturally was at the upper end of the tunnel which was eventually to tap a large body of water 60 ft. below its surface. By means of careful soundings and the exercise of the most minute precautions on the part of the engineers, the heading was driven to within 3.9 ft. of the lake-surface of the rock; but at this point the leakages become so considerable that it was deemed prudent to stop. But before leaving the heading 15 drill-holes were made and were charged with a total of 111 lbs. of dynamite.

These charges were fired electrically and an opening was made that admitted a flow of 3 cu. m. of water per second into the tunnel. As it was figured that a flow of 7 cu. m. per second was necessary for the speedy emptying of the 60-ft. depth of lake, the hole was enlarged by attaching to a "cross" made with old rails, a cartridge containing 11 lbs. of dynamite. This arrangement was lowered from a boat, and drawn by the current into the hole and fired electrically. With this enlarged opening the lake was emptied in 27 days.

After building a temporary dam at the lake end of the tunnel for controlling any rise in the lake, a strong dam was built across the tunnel on the lake side of the shaft. This dam was 27 ft. long on the base, and was made of cut stone, laid in Portland cement mortar; it was larger on all sides than the normal tunnel section by 1.64 ft. Into this masonry were built 12 iron pipes, arranged in three rows, with no one immediately under the other. Of these pipes 9 were 12 ins. diameter and 3 of 6-in. diameter; the latter being put in to permit the closer manipulation of the gates and to better guard against any dangerous water-ram in closing the pipes. The valve rods extended through the arched roof of the tunnel into the chamber mentioned; and a stone stairway built in the shaft provided access from the surface. Including the building of roads of access, houses for the guards and workmen, telegraph line, etc., the total cost of this work was $60,400.

## SEA-GOING HYDRAULIC DREDGES FOR THE EAST CHANNEL IMPROVEMENT, NEW YORK HARBOR.

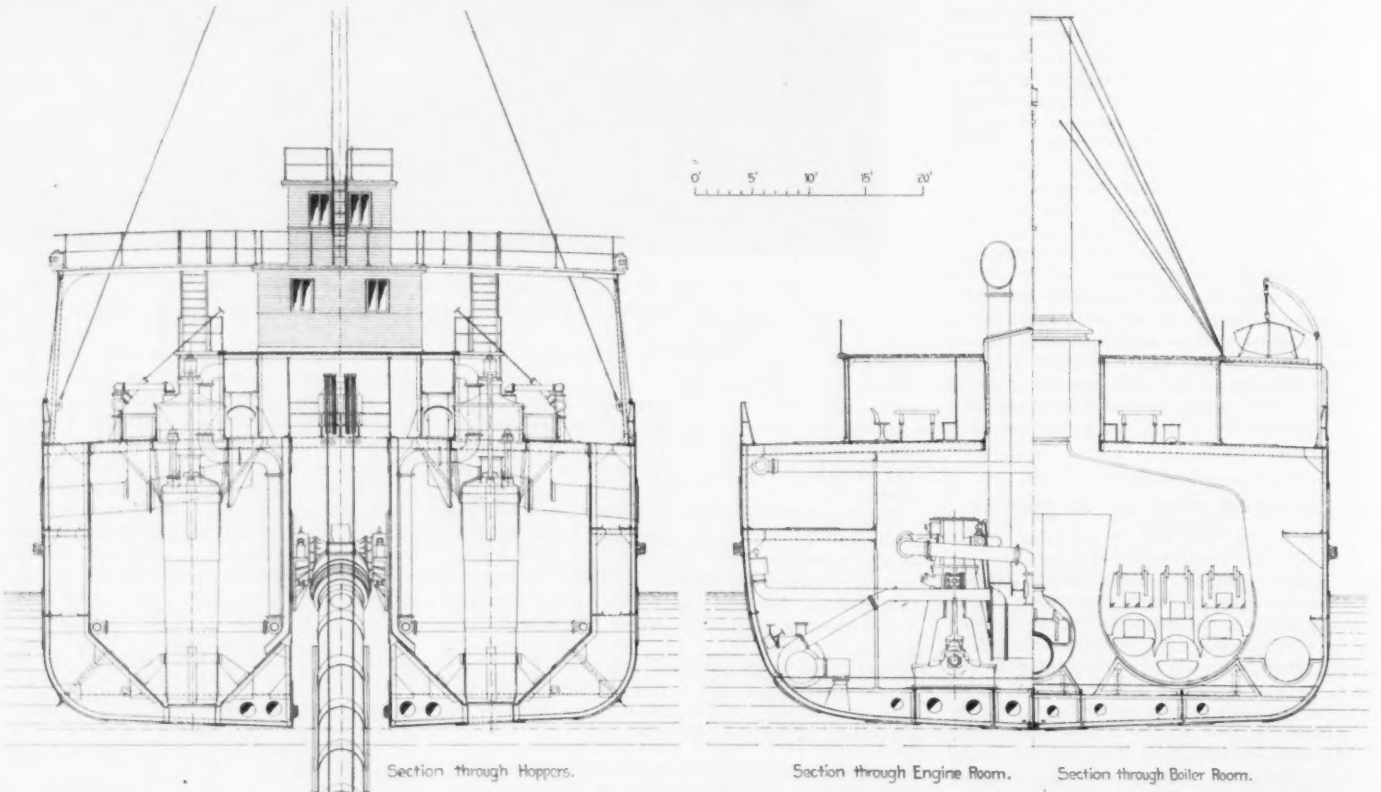
(With full-page plate.)

Two of the largest and most thoroughly equipped hydraulic suction hopper dredges ever constructed in America have recently been completed for the Metropolitan Dredging Co., of New York city, organized to carry out the contract for dredging about 40,000,000 cu. yds. of sand and mud in the East Channel improvement at New York Harbor, which was awarded to Mr. Andrew Onderdonk in 1899. The general plans of these dredges are illustrated on our two-page plate and in the accompanying cuts. Briefly described, each of these dredges is of 7,000 tons displacement, 300 ft. long, 52 ft. 6 ins. beam, 25 ft. molded depth, and has a hopper capacity of 2,800 cu. yds. of material and a speed of 10 knots. For the matter from which the description and illustrations of these machines have been prepared we are indebted to the Metropolitan Dredging Co.

The project for the East Channel improvement at New York Harbor was authorized by Congress at its session of 1898-9, and bids for carrying out the work were received on March 24, 1899. According to the specifications upon which bids were asked the work to be done was as follows:

> The channel known as East Channel, at the entrance to New York Harbor, is to be made 2,000 ft. wide and 40 ft. deep at mean low water throughout its entire length between the Main Channel and the sea, where the present depths generally range from 16 to 40 ft. The amount of excavation necessary to complete the above described work will not exceed 39,020,000 cu. yds. measured in place. The mean rise of tide is 4.6 ft. So far as is known the material to be excavated is mainly sand in the outer or seaward part of the channel and mud in the inner part, with small but varying proportions of fine gravel, shells and clay. The average distance to place of deposit in deep water in the ocean will be about eight miles. The amount of money now available for payments for excavation under the contract is $950,000. The contractor must begin work of excavation within twelve months from the date of approval of the contract. The rate of progress required for the East Channel work is for the first year 400,000 cu. yds. per month for eight months, and for each succeeding year 1,200,000 cu. yds. per month for eight months. All excavation is to be paid for by scow measurement.

Only one bid was received for the work, this bid coming from Mr. Andrew Onderdonk, of New York city, and offering to remove 40,000,000 cu. yds. of the materials specified for 9 cts. per cubic yard. In his bid Mr. Onderdonk stated that two dredges would be employed, or more if necessary. After consideration by the engineers of the War Department, this bid was accepted in May, 1899. Shortly afterwards Mr. Onderdonk associated with him Mr. D. O. Mills and Gen. Samuel Thomas and organized the Metropolitan Dredging Co. This company decided to build two dredges for the work, and engaged Mr. Walter Bailey and Mr. James Symington to prepare plans and specifications for machines of the hydraulic type. These engineers consulted with Mr. A. G. Lyster, Chief Engineer of the Mersey Docks, and with the engineers of the Marine Department of the Maryland Steel Co., and perfected plans for dredges modeled in respect to general principles upon the dredges "Brancker" and "Crow," employed in the Liverpool harbor work, but embodying many improvements in machinery and general equipment.




Section through Hoppers. Section through Engine Room. Section through Boiler Room.

TYPICAL TRANSVERSE SECTIONS OF HYDRAULIC HOPPER DREDGE FOR EAST CHANNEL IMPROVEMENT, NEW YORK HARBOR.

The main dimensions of the dredges for the New York Harbor work have already been given. As will be seen from the general plans, the hulls are of steel, and are provided with two decks. For about 125 ft. amidships the hull space below the main deck is taken up by a row of hoppers on each side, there being six hoppers in each row, two being 22½ ft. long by 18 ft. wide, and four being 20 ft. long by 18 ft. wide. The forward portion of the space between the two rows of hoppers is occupied by the well for the suction pipe. Aft of the hoppers the hull space below the main deck is given up to the main engine and boiler-room, propeling machinery and steering gear, and forward the corresponding space is devoted to the pump and pumping engines. The space between the main and upper decks is devoted chiefly to the quarters for the officers and men. The upper deck carries the derricks, windlasses and usual above-deck structures of a sea-going vessel. Taking up the description of the various parts named in more detail, we have first to consider the dredging machinery and hoppers.

The space forward of the hoppers, which is devoted to the dredging machinery, extends the full width of the vessel and for 50 ft. fore and aft. The main centrifugal pump is located in the center close to the forward end of the suction pipe well. It is a 48-in. pump built by the Morris Machine Works, of Baldwinsville, N. Y., and has two side pipes to the suction pipe and two discharge openings connected with separate discharge pipes leading to the two rows of hoppers as shown by the drawings. This pump is operated by two tandem, compound 17 × 30 × 36-in. stroke cylinder engines, exhausting into condensers. The pump has a guaranteed capacity of 75,000 gallons of water per minute, and will operate under a resistance equal to about 40 ft. head of water. The centrifugal pumping engines are placed forward of the pump, and forward of them is a large compound condensing duplex pump made by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, O., for the water jets on the section drag and in the discharge valves of the hoppers. This pump has 18 × 30-in. steam and 24 × 24-in. water cylinders. Another duplex pump, with 6 × 18-in. plungers, capable of pumping against a pressure of 1,000 lbs. per sq. in., is employed for operating the hydraulic cylinders by which the discharge valves in the hoppers are actuated and also for operating the hoists for raising the suction pipe.

The hoppers have rectangular bodies terminating in frustums of rectangular inverted pyramids at the bottoms. The discharge outlet in the bottom of each hopper is 4 ft. in diameter, and is closed by a trunk valve of the same diameter which extends up through the hopper and is raised and lowered by a 12-in. hydraulic cylinder. In operation this trunk valve is raised about 3 ft. to allow the contents of the hopper to discharge. To facilitate the discharge of these contents and to loosen them up so that the trunk valve may be easily hoisted, water is forced through the jets in the discharge valve by the pump previously mentioned. When the discharge is completed the centrifugal pump is started, forcing clear water through the discharge pipes and into perforated flushing pipes located in each hopper around the walls at a point where the vertical and inclined sides join. This operation cleanses the discharge pipes and the hoppers of all the undislodged contents.

The main boiler and engine-room contains two boilers 14 ft. in diameter and 11 ft. 10 ins. long operating under 180 lbs. steam pressure, and between the main boilers there is also a 7½ × 9-ft.

donkey boiler. Aft of the boilers are located two inverted cylinder, direct-acting, triple-expansion engines, with 18, 25 and 48-in. cylinders, with 30 in. stroke. The high pressure and intermediate cylinders have piston valves, and the low pressure cylinder has slide valves. These engines drive twin screws.

The operation of the dredge is as follows: The suction tube is lowered to the bottom and the air exhausted from the centrifugal pump by a 4-in. injector. When the pump is charged the pumping engines are started filling the tanks with water. The suction pipe having fed itself into the bottom to a sufficient depth, the dredge is moved ahead at a speed of about 25 or 30 ft. per minute, until the hoppers are filled with dredgings. To loosen the material so that the suction can secure it, the water jets previously noted are kept in operation. When the hoppers are filled the suction pipe is raised, and the dredge proceeds to sea, where it discharges its load by performing the series of operations previously described.

The fittings of the dredge are unusually complete throughout, and a particular attempt has been made to provide comfortable quarters for the officers and crew. These quarters, together with the mess-rooms, pantries, etc., are located above the main deck, as shown by the drawings on our two-page plate. These drawings also show in sufficient detail the above-deck structure and rigging. The two dredges have been named the "Thomas" and the "Mills," and were built at the yards of the Maryland Steel Co., at Sparrows Point, Md.

The first dredge launched, the "Thomas," was brought to New York for some tests on the New York bar, and is now at dock waiting completion of the jet appliances to the suction pipe. In the preliminary tests, stones, bricks, etc., were easily handled by the pumps, and discharged into the hopper. The suction gratings exclude any size stone that will not pass the pump.

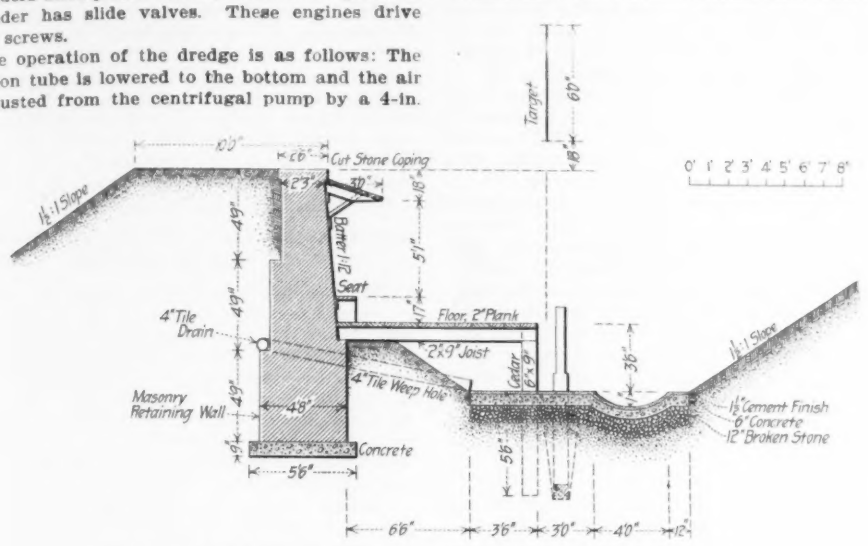



FIG. 1.—SECTION OF MARKERS' SHELTER, FOR RIFLE RANGE.

## THE LAYING OUT OF RIFLE-RANGES.

Literature upon the proper location, arrangement and construction of military rifle-ranges is so scarce that we abstract a paper upon this subject presented on Dec. 20, 1900, to the Canadian Society of Civil Engineers by Mr. G. S. Maunsell, A. M. Can. Soc. C. E. As Canada possesses about one hundred ranges of this class, coming under the control of its Department of Militia and Defence, the proper construction of such ranges has been carefully studied, and the plans here presented are supposed to represent the best Canadian practice.

It is first pointed out that the introduction of modern high-power arms and the increasing density of population have rendered it more difficult than formerly to provide a safe range. In fact no rifle-range is absolutely safe, especially where inexperienced men are firing; there is always some danger from a ricochet or wild shot, to say nothing of a premature discharge of the rifle.

In Canada the Lee-Enfield rifle is now used, with an extreme range of from 3,500 to 4,000 yds. To stop bullets from this rifle, we must have 24 ins. of earth, not rammed; or ⅜-in. of mild steel plate; or 38 ins. of fir; or 24 ins. of oak. The background behind targets is therefore a very important point. If the country beyond is level—even with an artificial butt, the clear length of ground behind the targets should be at least 2,000 yds. If a natural stop-butt, or hill exists, the slope behind the targets should be 1 on 1, to prevent ricochet, and this should be 50 ft. in rear of the targets. If the proper slope is not naturally provided it should be scarped.

The standard of construction, adopted by the Department of Militia and Defence and applicable only to the larger ranges, is here shown. Fig. 1 shows the trench for the protection of the markers, 4 ft. or more deep, according to the nature of the ground; with a retaining wall in front, 8 ft. high above the markers' platform, and a natural slope of earth in the rear. A stop-butt, 25 ft. high, is placed 50 ft. in the rear of this trench, and is made of cribwork filled with stone.

The target-frame, Fig. 2, consists of a steel frame holding any size of target; with the target made to slide up or down, by means of pulleys, and counterbalanced either by the weight of another target or by that of a dummy. If two targets are fitted for each frame, discs are used for marking; if the dummy is employed the marking is done upon it.

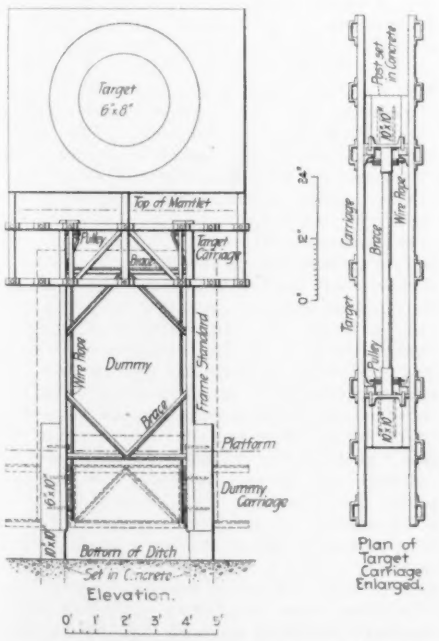



Fig. 2.—Plan and Elevation of Movable Target Frame.

Aside from these standards, the construction of the different ranges varies according to the nature of the ground, the number of targets, etc. Sometimes, when the soil permits and drainage is obtainable, the markers' trench is made 7 ft. deep and an ordinary "window-frame," or revolving target, is used. If the soil is rocky and not easily excavated, the cribwork mantlet, Fig. 3, is constructed. This is 8 ft. high above the markers' platform, is 8 ft. thick on top, is filled with earth and lined on the interior face with ⅝-in. steel plates. From this mantlet target-carriages are run out on tracks on either side; and these targets are run in behind the mantlet to patch and to mark.

## NOTES ON TWO SMALL SOUTHERN WATER-WORKS PLANTS.

A small water-works system was put in operation at Pratt City, Ala., about Dec. 1, 1900. The works are owned by the city and were built by contract, with Alber & Byrne, of Birmingham, as engineers. The supply is drawn from two 8-in. wells, sunk in the rock, one being 354 and the other 259 ft. deep. Each well is provided with an air lift pump, the water pipe being 4 ins. and the air pipe 1¼ ins. in diameter. The air pipe goes down 200 ft. and is designed to give 50% submergence. The air compressor is designed to lift 300 gallons of water per minute and 306 gallons have been raised from both wells.

The air lifts discharge into a 100,000-gallon reservoir, roofed with a wooden frame and steel covering. Two 500,000-gallon pumps force water to a 12 × 100-ft. stand-pipe, or directly to the mains, if desired. There are nearly three miles of 8 to 4-in. cast iron mains and 32 two-way hydrants. All the pumping machinery was supplied by the Smith-Vaile Co. Mr. G. W. Donaldson, City Clerk, will act as superintendent of the works. Mr. E. T. Hudall is Mayor.

An interesting little plant was started at Elberton, Ga., about a year ago, but has not been completed, owing to the failure of the people to vote the necessary bonds. Some springs were developed by excavating and walling up a reservoir about 40 × 45 ft. in plan, with 12 ft. of water. Portions of the reservoir bottom where rock was not reached are covered with 16 ins. of concrete. The side walls are of rubble, 18 ins. thick at the top and 30 ins. at the base. The reservoir is covered with a wooden frame and shingle roof.

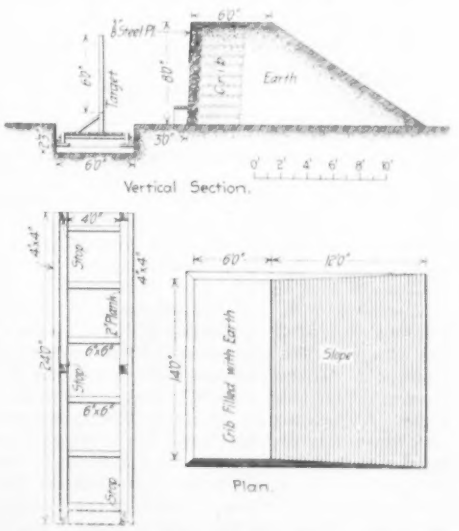



Fig. 3.—Markers' Shelter and Target Carriages for Two Targets.

Connected with the reservoir is a small power house, 17 × 19½ ft., outside dimensions. Here an electric pump, with a capacity of 300 gallons a minute, will be placed. The current to drive the pump will be supplied from the city lighting station, some three or four miles distant, where it is generated by water power. Alber & Byrne were also the engineers for this plant, and we are indebted to them for the information from which these notes have been prepared.

# ENGINEERING NEWS
AND
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*ADVERTISING RATES:* 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*


Our genial contemporary, "Life," remarks that, according to the revised Catechism, the world was created about 4,004 B. C.; but it was reorganized in 1901 by J. Pierpont Morgan and others! The latest feature of this reorganization is the reported acquirement of control of the Carnegie Steel Co. by Mr. Morgan and capitalists associated with him, who also control the Federal Steel Co., the American Steel & Wire Co., the American Bridge Co., the National Tube Co., and the Pressed Steel Car Co. About the only authoritative statement to the public concerning the matter is that made by President Gary of the Federal Steel Co., who on Feb. 8 stated substantially that the banking firm of J. P. Morgan & Co. are considering plans for the acquisition of the properties of some of the largest iron and steel companies in the country. This enterprise, Mr. Gary assures us, will result "in great benefit to the investor in securities, the consumers and the employees," which translated means, if it means anything, that the investor will receive larger dividends, the consumer lower prices and the workman higher wages. Desirable as such an all-around bestowal of benefits may be, it is a little difficult to see how a simple transference of ownership can accomplish such miracles. There has long been a current impression that the Carnegie Steel Works, for example, was a pretty well managed enterprise. Has Mr. Morgan a "captain of industry" up his sleeve who can so manipulate this great business as to sell steel at lower prices and at the same time pay both higher wages and bigger dividends? We confess to a little incredulity on this point.

If one applies ordinary common sense to the problem, he must conclude that those who are scheming to bring about the final consolidation of the great steel-making combinations are in all probability actuated by the ordinary motives of gle's stock so that they can sell rails more cheaply, so that they can sell rails more cheaply, or pay the rolling mill men higher wages, or even to pay bigger dividends to the little stockholders scattered here and there. It is fair and charitable to suppose that the idea of "harmonizing the steel situation" and eliminating the independent Carnegie Co. as a competitive factor is one of the motives leading towards the proposed consolidation. Mr. Carnegie's projected immense tube-making plant on the shores of Lake Erie, which would have interfered so seriously with the business of the National Tube Co., was doubtless an important factor in bringing negotiations to a head. So far as the proposed "harmonizing" operates to prevent needless multiplication of productive facilities, beyond the capacity of the markets to absorb, we may concede that Mr. Morgan and the other "harmonizers" will effect some such all-around benefits as Judge Gary claims. Incidentally they will probably also reap a generous profit for themselves. And it is profit, not philanthropy, that is the moving force in the manufacture of Wall Street combinations.

The announcement in an Associated Press dispatch on Feb. 8 that the British government will not accept the Hay-Pauncefote treaty with the Senate amendments, but will submit counter-proposals instead, appears to end the chance of effective legislation for an Isthmian Canal at the present session of Congress. This means, of course, that the whole matter is postponed until next December at least, for the majority party in the Senate is not likely to undertake definite legislation until the Clayton-Bulwer treaty is out of the way. It has, indeed, been proposed that formal action might be taken to abrogate the Clayton-Bulwer treaty, after which the Nicaragua Canal bill could be passed; but it is altogether too much to expect that any such radical program can be initiated and carried into execution within the brief three weeks which remains of the present session of Congress.

At the opening of the session, the measure of general legislation which seemed most certain of passage before the final adjournment was the canal bill. Had the Senate been content to accept the Hay-Pauncefote treaty as originally submitted, there can hardly be a doubt that the canal bill would now be a law. We do not say that the Senate amendments were not on the whole an improvement to the original treaty. It is quite likely that they were an improvement. Moreover, they really contained nothing that could fairly be construed as contrary to Great Britain's interests. On this fact the majority party in Congress based their hopes for their unconditional acceptance by Great Britain in time to enact canal legislation at the present session. Even now we think it quite improbable that Great Britain is seriously objecting to the trifling modifications which the Senate has made. It seems more likely that she is seizing the opportunity to secure some diplomatic concession in other quarters as a return for her consent to the modifications which the Senate has made on the pending treaty. Time will doubtless straighten the diplomatic tangle without difficulty; but meanwhile the canal waits.

Attention is called to the peculiar state of affairs as regards water pollution in Indiana, set forth elsewhere in this issue. One of the bills there outlined is avowedly in the interests of the manufacturers of the State, but it is expected that it will at the same time protect the waters of the State from pollution. Can the two objects sought be attained in any such way? The bill seems to relieve the water polluters of the State from all responsibility until the State itself not only lays down the method to be adopted to stop the pollution, but proves its adequacy in a county court. If the method brought forward should be a failure and the pollution continue, what then?

It is true that other States, through their sanitary officers, have given advice in matters of water pollution and sewage purification and that Massachusetts has expended some $300,000 in water and sewage purification experiments at Lawrence to enable it to give better advice than would be possible otherwise; but in no previous instance has it been necessary for a State to provide a plan for obeying a law before it could proceed to its enforcement.

The proposed sanitary survey of Indiana, and likewise the proposed laboratory of hygiene, are excellent propositions, and the desire to secure relief from stream pollution through co-operation instead of persecution is also laudable; but the burden which would be placed on the State if it were compelled to provide a remedy for water pollution before it could enforce its own statutes against such pollution seems altogether too great.

### SOME FINANCIAL, POLITICAL AND SANITARY PHASES OF GARBAGE DISPOSAL.

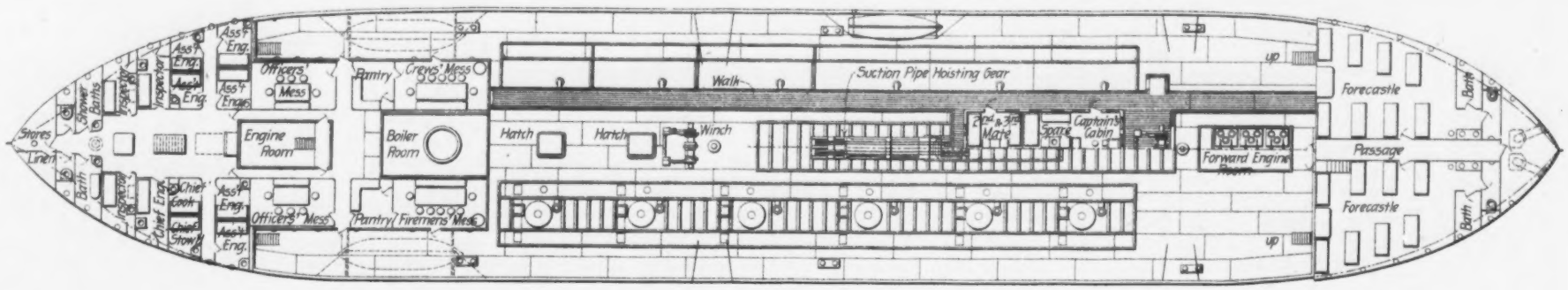
The possibilities of utilizing heat from garbage furnaces have been discussed with more or less seriousness this side the water and have been put to practical test for some years in England. Nothing very conclusive has been published yet as to the results abroad and there has been great doubt as to whether such conclusions would be of much value here, unless adverse, owing to the apparent greater fuel value of English over American garbage. If this apparent superiority is real, failure in England would indicate failure here, particularly as the English furnaces seem to be far ahead of most of those already in use here. Happily, there is promise of a practical test of this question at Chicago, where a garbage furnace is to be operated at one of the city electric lighting stations, in charge of Mr. Edward B. Ellicott, City Electrician. The furnace is described elsewhere in this issue.

We have received a letter from Dr. Arthur R. Reynolds, Health Commissioner of Chicago, in which he expresses the following opinion as to burning garbage:

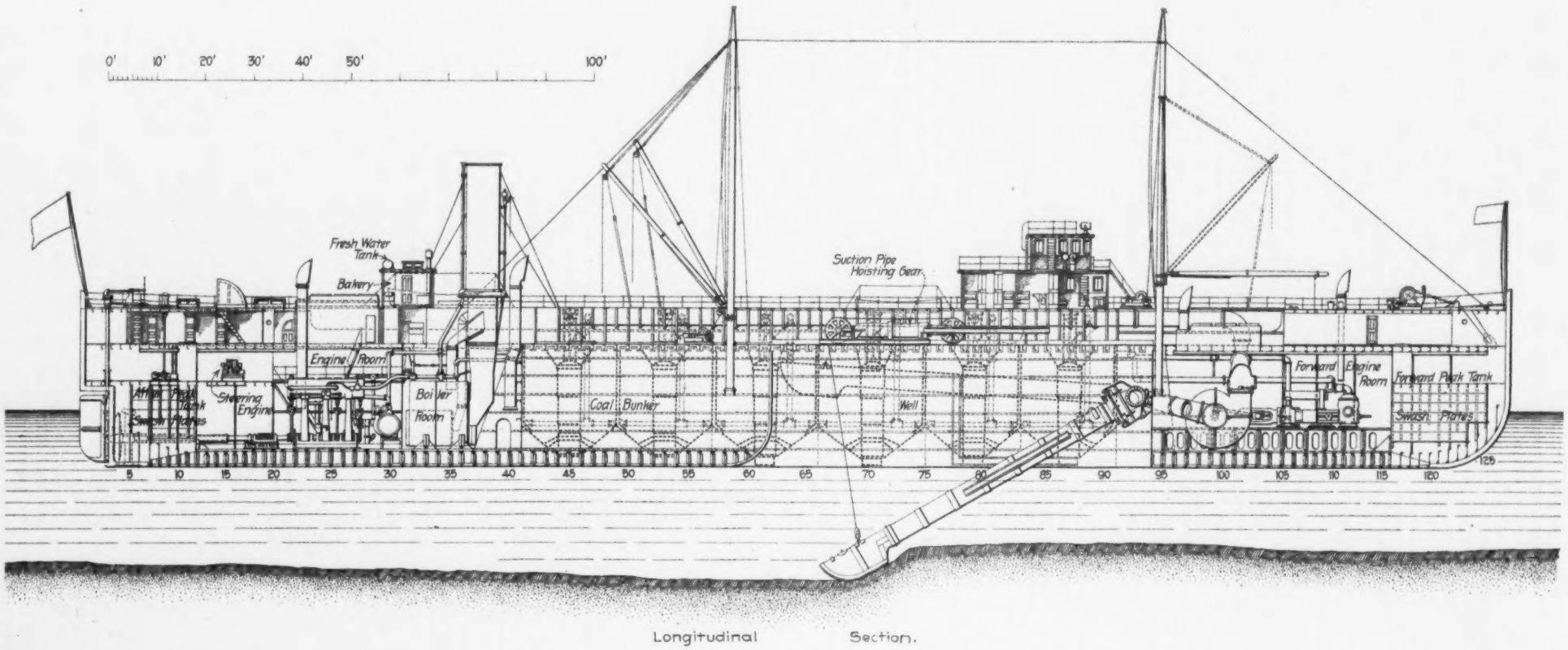
> While much of the city's waste is combustible and can only be disposed of by fire, I believe it an economical error to burn up garbage, for the reason that it will yield an item of considerable value by extracting the grease and fertilizer from it.

It is a pity that we have so little scientific data on this very point, or information of any sort, that is either extensive or reliable. All of the reduction plants for treating garbage have been built and operated by private companies, and they have considered it most decidedly for their interest to keep the financial results very much to themselves, particularly as they always ask and receive compensation for treating the garbage, notwithstanding their claims as to the value of the grease and fertilizing material obtained therefrom. It is a significant fact that nearly all the large city contracts for garbage disposal do involve reduction, rather than burning, but of what is this significant? A careful study of local conditions would show that in many cases this choice does not necessarily mean that reduction will be cheaper to the city than cremation, or might have been if the selection and development of a plant had been left to a competent engineer, but simply that there being no real competition from furnace men the contractor considered that his own ends would be served most fully if he adopted reduction. Many of the reduction plants neither stand on their own bottom nor exist for themselves alone; they have been built by or in the interests of promoters of patented processes, sometimes with no expectancy of making a direct profit, but rather to secure a foothold for a new process, or as a valuable aid to the floating of stock. Again, it has been easier to initiate a movement for some improved means of garbage disposal by holding up to public view a system for which big claims were urged as to the low prices made possible through the utilization of the garbage, instead of sending it all up in smoke. The movement once started and local politicians interested it is a rare thing for a city to give any intelligent consideration as to whether or not reduction really is the cheapest. If, perchance, a disposal contract has been thrown open to the bids of all comers the promoters of reduction processes have had the advantage heretofore of superior financial and political backing, better organization generally, and more experience in handling garbage on a large scale, than were possessed by the furnace men.

As a partial offset to the greater capital required for reduction than for cremation there has



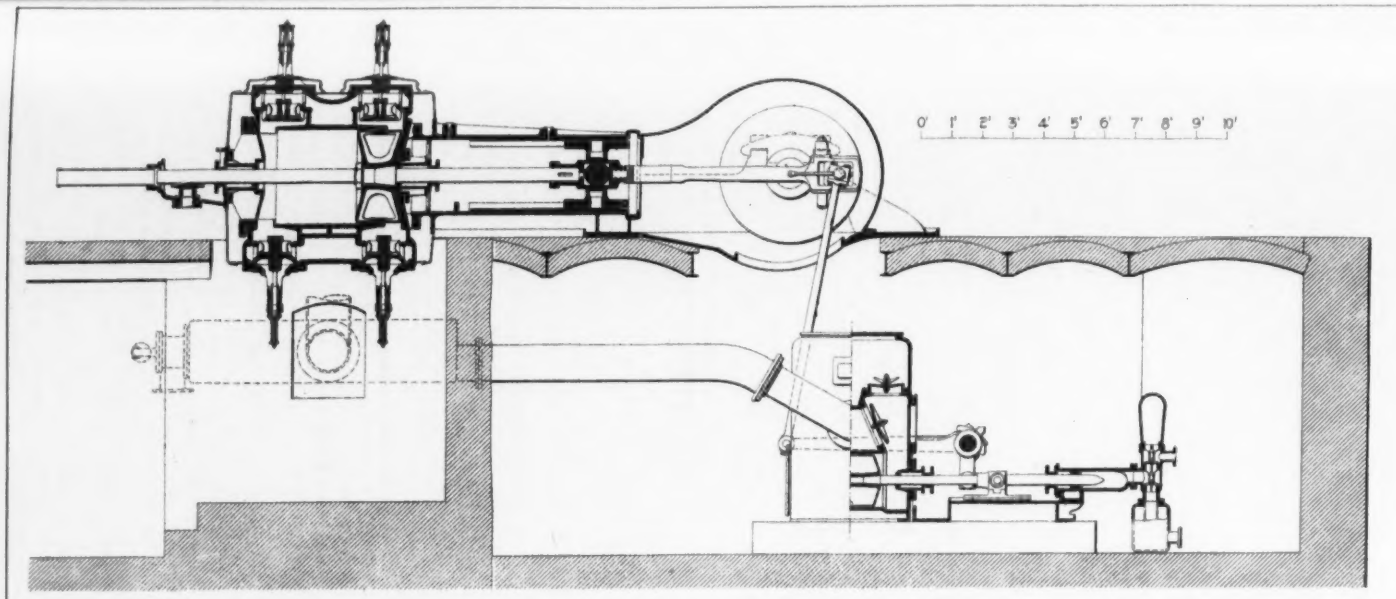

Sectional Plan.


0' 10' 20' 30' 40' 50' 100'
Fresh Water Tank
Bakery
Engine Room
Boiler Room
Steering Engine
Coal Bunker
Well
Suction Pipe Hoisting Gear
Forward Engine Room
Forward Fresh Tank
Swash Plates
Swash Plates
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125

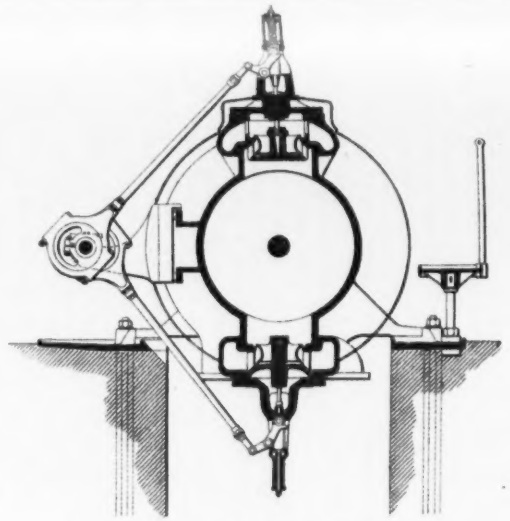
Longitudinal Section.

## HYDRAULIC HOPPER DREDGE FOR EAST CHANNEL IMPROVEMENT, NEW YORK HARBOR.

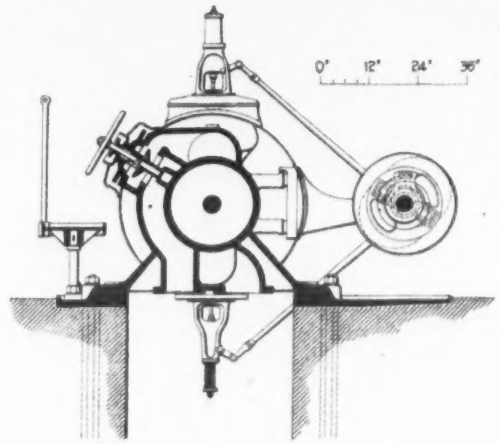
**Metropolitan Dredging Co., New York, Contractors.** **Maryland Steel Co., Sparrows Point, Md., Builders.**



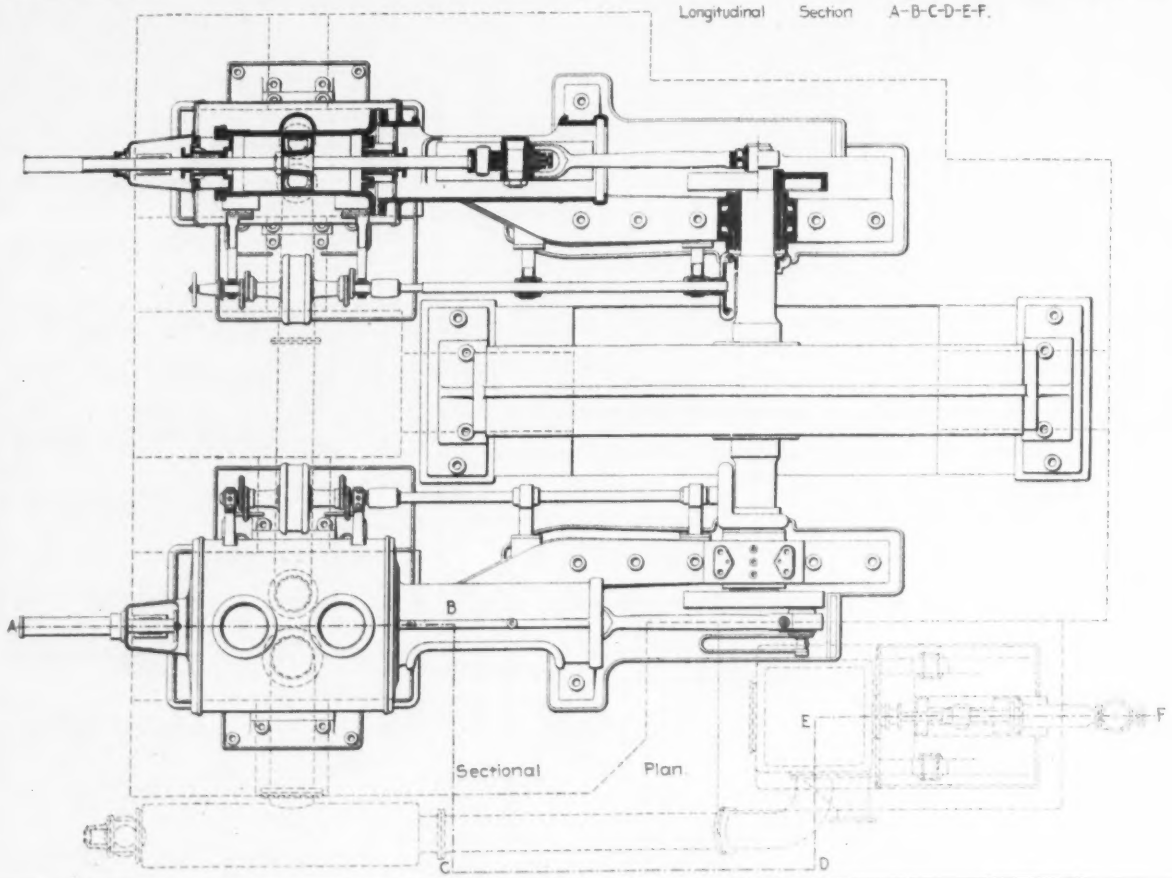

Longitudinal Section A-B-C-D-E-F.



Cross Section Through Low Pressure Cylinder.




Cross Section Through High Pressure Cylinder.




# 1000-HP. COMPOUND ENGINE WITH LENTZ VALVE GEAR.

First Brünner
Machine Manufacturing Company,
Brünn, Austria,
Builders.

CHAS. HART, LITH., 36 VESEY ST., N. Y.

been the revenue from the saleable products of reduction. Even the insiders have often been deluded as to these, while as for the general public it is always ready to be led into a scheme promising to evolve something out of nothing. It is doubly easy to enlist its capital in an enterprise involving the utilization of city wastes, known to possess ingredients of commercial value, however problematical and costly their recovery may be. Thus it will be seen that the mere fact that most of the large garbage disposal plants of this country employ reduction rather than cremation is not conclusive evidence that the former process is more profitable than the latter to the contractors. It has even less bearing upon the question which process would really be cheapest for a large city, provided one should some day have the courage and intelligence to attack the garbage disposal problem as most cities now handle water supply and sewerage questions; that is, entrust them to competent engineers, with the understanding that plans and specifications for a system best adapted to local conditions are to be prepared after exhaustive study of all the factors involved and the contract thrown open to competition, with the assurance that the bids received will be on a comparable basis.

The presumption is that the capitalists who have invested in garbage reduction plants did so with the belief that there was more money for them in that direction than in garbage furnaces, but, as has been pointed out, the profit has been looked for, oftentimes, in the stock of parent or proprietary companies, rather than in the actual handling of garbage, and not infrequently it has failed to materialize from either source. Moreover, it is a fact that many of the reduction plants now in operation are either not yet through with their first contract period, or that the contracts have been renewed, as some of them were let at the outset, with no competition from furnace men. Some of the reduction contracts have been renewed without competition of any sort, or without any worthy the name. The most recent case in point is the Philadelphia contract, where bids for one year only were invited some two months in advance of the date set for putting the new contract into effect, in the face of a fully equipped plant which had been operated for a number of years by some of the most experienced garbage reduction men in the country. Only one result was to be expected, and although something quite contrary did occur, namely, a new company heavily underbid the established one, and secured an award of the contract, in less than two weeks after the expiration of the contract for 1900 the old contractors were again handling all the garbage of the city. To be sure, various allegations of police interference, due to political pressure, were made, and some lawsuits are pending, but the new company had not executed the contract and complied with the guarantee terms when it took up the work. If there was any force in the allegation of political interference, it merely goes to prove our statement that political backing is an important element in the garbage disposal situation.

We may now come back to the utilization of the heat from garbage furnaces for electric lighting or other purposes, as proposed at Chicago; and also at Grand Rapids, Mich., after July 1, 1901. Without attempting to predict the success or failure of these experiments, for such they will be for the United States, we suggest that these two plants may perhaps mark a new era in garbage disposal in this country, through making the burning of garbage as attractive to investors as its reduction; or if not as attractive, certainly more so than now.

Any one familiar with the history of garbage disposal in this country knows, or can see on careful thought, that the status of garbage furnaces would be far different to-day if more engineering skill and business ability had been behind them ten or twelve years ago and if we had kept pace with the development in the same line in England. There has been some improvement of late, but nothing like what is needed or possible, in an engineering way, while the business end of the industry seems to have progressed largely through the application to the smaller cities of the same doubtful political expedients as have been employed so successfully in the larger cities to further the garbage reduction processes. The political entrenchment of the garbage reduction interests is so strong, the financial claims for the process are so alluring, and the general organization of the promoters of garbage reduction appears to be so far superior to that of the men interested in cremation, that we can scarcely expect to see garbage cremation assume equal place with reduction until it makes itself equally strong at all these points, or so much stronger at some one of them as to gain the ascendency on that account. Political strength in such a field cannot be too severely condemned, and is uncertain at best. Financial strength may be gained, temporarily, by visions of profits from the utilization of heat, but to be lasting it must rest on such sterling qualities as minimum cost for maximum sanitary results. What can be achieved in this line and to what extent the combination of garbage furnaces and electric light plants will aid in a financial way are questions for furnace men and municipalities to answer, but they never will answer those questions satisfactorily until they call competent engineers to their assistance and cut free from reliance upon political influence rather than sterling merit.

A question having an important bearing upon the choice of a system of garbage disposal is whether garbage, ashes and other household and business wastes shall be dumped into one receptacle, or kept separate in two or more. With the reduction system of disposal, garbage must be kept separate, and collected in the same way. If furnaces are used everything may, perhaps, be mixed, although the wisdom of fouling clean ashes with garbage is questionable, if its prevention is practicable. A strong argument against mixing, even if the garbage is to be burned, is made by Dr. Reynolds, in the letter to this journal, from which a quotation has already been made. Dr. Reynolds says:

> I am in favor, not only of separating garbage from ashes, but separating garbage from all other wastes, and collecting it and disposing of it distinct and separate from every other form of waste. Ashes, paper and all other waste may lie upon the streets, in alleys or yards of a city without doing any positive harm, from a sanitary standpoint, while putrifying garbage is always a distinct menace. When garbage is left to decay it furnishes food and a resting place for rats, mice, flies and other vermin, all of which are a pest. With our present knowledge of the part played by insects and vermin in spreading disease, the attention of the sanitarian must be turned to their destruction, and I know of no better way to destroy them than to take from them the food upon which they live and this food is chiefly garbage from houses and manure from barns.

The forcefulness of this argument is yet more apparent when it is remembered that by keeping and collecting garbage by itself the frequency of its removal may be increased and that the expense of a double removal may be partially offset by a much less frequent service for ashes and other wastes than would be sanitarily possible when everything is collected together.

## LETTERS TO THE EDITOR.

### Middle Ordinates in Inches for 20 and 25 Meter Chords

Sir: Being obliged while on railway construction in Mexico, to figure middle ordinates in inches for curving rails on curves of 20 and 25-meter chords, I found it convenient to make a table for same. Thinking that this may save others, in a similar position, the trouble of a similar calculation, I enclose a copy for publication.

Yours truly, H. deB. Forbes.

West Haven, Conn., Dec. 19, 1900.

A Table of Middle Ordinates for Curving 30-ft. Rails on Curves of 20 and 25-Meter Chords.
(Calculated to the nearest 1/16 of an inch.)

| | 20-meter chords. | | | | | 25-meter chords. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0′. | 10′. | 20′. | 30′. | 40′. | 50′. | 0′ | 10′. | 20′. | 30′. | 40′. | 50′. |
| 0° of curve | 0 | 1/16 | 1/8 | 3/16 | 1/4 | 5/16 | 0 | 1/16 | 1/8 | 1/8 | 3/16 | 1/4 |
| 1° " " | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 | 5/16 | 5/16 | 3/8 | 7/16 | 1/2 | 1/2 |
| 2° " " | 11/16 | 3/4 | 13/16 | 7/8 | 15/16 | 1 | 9/16 | 5/8 | 11/16 | 11/16 | 3/4 | 13/16 |
| 3° " " | 1 1/16 | 1 1/8 | 1 3/16 | 1 1/4 | 1 5/16 | 1 3/8 | 7/8 | 15/16 | 15/16 | 1 | 1 1/16 | 1 1/8 |
| 4° " " | 1 7/16 | 1 1/2 | 1 9/16 | 1 5/8 | 1 11/16 | 1 3/4 | 1 1/16 | 1 1/8 | 1 3/16 | 1 3/16 | 1 5/16 | 1 3/8 |
| 5° " " | 1 13/16 | 1 7/8 | 1 15/16 | 2 | 2 | 2 1/16 | 1 7/16 | 1 1/2 | 1 9/16 | 1 9/16 | 1 5/8 | 1 11/16 |
| 6° " " | 2 1/8 | 2 3/16 | 2 1/4 | 2 5/16 | 2 3/8 | 2 7/16 | 1 3/4 | 1 13/16 | 1 7/8 | 1 15/16 | 2 | 2 1/16 |
| 7° " " | 2 1/2 | 2 9/16 | 2 5/8 | 2 11/16 | 2 3/4 | 2 13/16 | 2 | 2 1/16 | 2 1/8 | 2 3/16 | 2 1/4 | 2 5/16 |
| 8° " " | 2 7/8 | 2 15/16 | 3 | 3 1/16 | 3 1/8 | 3 3/16 | 2 5/16 | 2 3/8 | 2 7/16 | 2 1/2 | 2 9/16 | 2 5/8 |
| 9° " " | 3 1/4 | 3 1/4 | 3 5/16 | 3 3/8 | 3 7/16 | 3 1/2 | 2 7/16 | 2 7/16 | 2 1/2 | 2 5/8 | 2 5/8 | 2 11/16 |
| 10° " " | 3 9/16 | 3 5/8 | 3 11/16 | 3 3/4 | 3 13/16 | 3 7/8 | 2 3/4 | 2 13/16 | 2 7/8 | 3 | 3 1/16 | 3 1/8 |
| 11° " " | 3 15/16 | 4 | 4 1/16 | 4 1/8 | 4 3/16 | 4 1/4 | 3 1/16 | 3 1/16 | 3 1/8 | 3 3/16 | 3 3/8 | 3 3/8 |
| 12° " " | 4 5/16 | 4 3/8 | 4 7/16 | 4 1/2 | 4 1/2 | 4 9/16 | 3 7/16 | 3 1/2 | 3 9/16 | 3 5/8 | 3 11/16 | 3 11/16 |
| 13° " " | 4 5/8 | 4 11/16 | 4 3/4 | 4 13/16 | 4 7/8 | 4 15/16 | 3 3/4 | 3 3/4 | 3 13/16 | 3 7/8 | 3 15/16 | 3 15/16 |
| 14° " " | 5 | 5 1/16 | 5 1/4 | 5 5/16 | 5 1/4 | 5 5/16 | 4 | 4 1/16 | 4 1/8 | 4 1/8 | 4 3/16 | 4 1/4 |
| 15° " " | 5 3/8 | 5 7/16 | 5 1/2 | 5 9/16 | 5 5/8 | 6 | 4 5/16 | 4 3/8 | 4 3/8 | 4 7/16 | 4 1/2 | 4 5/16 |
| 16° " " | 5 11/16 | 5 3/4 | 5 13/16 | 5 7/8 | 5 13/16 | | 4 9/16 | 4 5/8 | 4 11/16 | 4 3/4 | 4 3/8 | 4 13/16 |

### Co-operation Among Engineering Societies.

Sir: I wish to endorse your recent editorial concerning the co-operation of engineering societies, as I believe it is a step in the right direction. Specific progress and advancement comes through individuals, but the influence of such progress is exerted by the co-operation or grouping of such individuals. Again, a grouping of individuals for a given purpose with regard to that purpose may in some cases be considered as a unit and the law mentioned above would apply with this variation. Tersely expressed, man develops as an individual but exerts his influence as one of a group.

In the industrial development, especially in this country, engineering is playing and is to play in far greater measure, an all important part. Much is to be done in the engineering field as regards education, practice and a professional standing.

The great engineering societies of this country have a good membership, but at the same time there are many things which are suggested but which cannot be put through on account of lack of financial backing or other reasons. One such project is a standardizing laboratory.

Again, there are a number of engineering societies situated in the various large cities throughout the country, which societies have at their meetings very able papers presented. I am heartily in favor of any movement that will bring about a co-operation between engineering societies. In the matter of quarters, in the matter of meetings and in the matter of special projects, I believe much benefit would accrue to all. Yours very truly,

John Balch Blood, M. A. I. E. E., M. Bost. Soc. C. E., Assoc. M. A. S. M. E

Equitable Bldg., Boston, Mass., Feb. 7, 1901.

### The Competency of Correspondence School Graduates.

Sir: In reply to the letter appearing in your issue of Feb. 7th, bearing on the incompetency of correspondence school graduates, the writer would like to say, that although the criticisms of "Chief Engineer" are probably perfectly just in the few cases which have been brought to his attention, it does not necessarily follow that the correspondence course is without value. In fact, the writer is confident that any person of average intelligence who has enjoyed the benefit of a common school education and who will conscientiously pursue a correspondence course may fit himself for one of the numerous engineering branches and successfully compete with the college-bred man.

It might be well to say in this connection, that indolence is just as prevalent in colleges as among students of correspondence schools, but the college sloth will probably have to do more of the so-called cramming to obtain his diploma, which the writer believes to be a doubtful benefit. I have omitted the social advantages, only obtainable in a course of study which forces one to intermingle and compete with others, and the consequent polish or culture which is usually illustrated in the college man: though it has no particular bearing on one's ability to perform geometrical, or trigonometrical calculations. I shall conclude with the hope that the next correspondence-school scholar answering the advertisements of "Chief Engineer" will be of the more persevering class, who take up the course with a view of benefiting themselves and not rushing through to gain a diploma, which of itself is of no value. Respectfully.

Bound Brook, N. J., Feb. 11, 1901. R. 401.

### The Safety of Shell Boilers.

Sir: I have been much interested in your editorial comments in your issue of Jan. 31 on my article on "Thickness of Boiler Plates." There have been practically no explosions in the boilers insured by the Mutual Boiler Ins. Co., or at any rate too few to serve as the basis of any statistics; but it appears to us from such information as we can obtain, that while certain types of boilers

known as "safety boilers" may be free from danger of any great explosions, yet that they are liable to numerous small explosions, such as the blowing out of a water tube, etc., and that the total losses from these many small explosions will be as great as the loss from a single explosion of a shell boiler.

Further, we have as yet been unable to learn of any case whatsoever where a horizontal return-tubular boiler, made with good metal, with butt-strap joints, has exploded. Such boilers have now been made for many years, and if they have never exploded we do not see why they are not best entitled to the name of "safety boiler."

I think it would be of interest if you would ask the readers of Engineering News to report any explosions of such boilers that have occurred within their knowledge.

Truly yours, R. S. Hale.

No. 31 Milk St., Boston, Feb. 1, 1901.

(We think it likely that few cases of the explosion of butt-strap joint boilers could be found, for the reason that few boilers of this class have been built, compared with the number built with ordinary lap joints. It does not appear, however, why butt-joint boilers should be safer against other causes of explosion, such as external or internal corrosion, or accumulation of dirt or scale on the shell over the fire, than boilers built with lap-joints. Where good, pure water is available for boiler supply, as in New England, the return-tubular boiler is comparatively safe and long-lived. Where bad water must be used, as in many parts of the West, much greater vigilance is necessary to keep such a boiler in safe condition, and sometimes this vigilant care is omitted with disastrous results.—Ed.)

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Sir: In your editorial, referring to a 90-in. return-tubular boiler with ⅝-in. shell, advocated by Mr. Hale, the difference in expansion between the two sides of the plates, with a difference in temperature of 168°, seems to have been neglected. The difference in expansion would be about ¼-in. for the surface exposed to the fire; and, if Mr. Hale's estimate is correct, I have no doubt it is the explanation for a great many fractured plates.

Some experiments were made on "transmission of heat through plates" in 1893 by Sir A. J. Durston (Vol. 34, Br. Inst. N. A., p. 130), and, if I am not mistaken, a 1¾-in. plate was made red hot on one side while the other side was in contact with water.

I agree with Mr. Hale that it is safe to use large drums, when properly proportioned (vide the Scotch boiler), but I can not admit that it is proper or safe to apply the higher temperatures to the outside of the shell.

Yours truly, John C. Parker.

1041 Drexel Bldg., Philadelphia, Feb. 7, 1901.

(If our recollection of the Durston experiments is correct, the high temperature of the plate referred to by our correspondent was only reached when the plate was coated with a layer of grease, which obstructed the passage of heat from the plate to the water.—Ed.)

### Notes and Queries.

In the tests of the Worthington pumping engines at the Ridgewood pumping station, described in our issue of Jan. 31, the bonus referred to was for duty in excess of the contract rate, and not for excess capacity, as stated in the article.

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A. S., New York city, sends a sketch of a rail section having the sides of the head inclined like the old Lehigh Valley section instead of vertical, as in the Am. Soc. C. E. section, and asks where the gage of the track is measured with such rails, at the top of the head or at the bottom. We submit the question to our readers.

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H. G. P., Little Rock, Ark., writes that he has a round-house to design and desires to know whether steel roof trusses of 75-ft. span will be preferable to wooden ones, and whether ordinary painting with good ventilation will be sufficient to preserve them from corrosion. The objection to wooden trusses is, of course, the danger from fire. We shall be pleased to hear from readers who can report as to the life of steel roof trusses in such locations, or methods of protecting them.

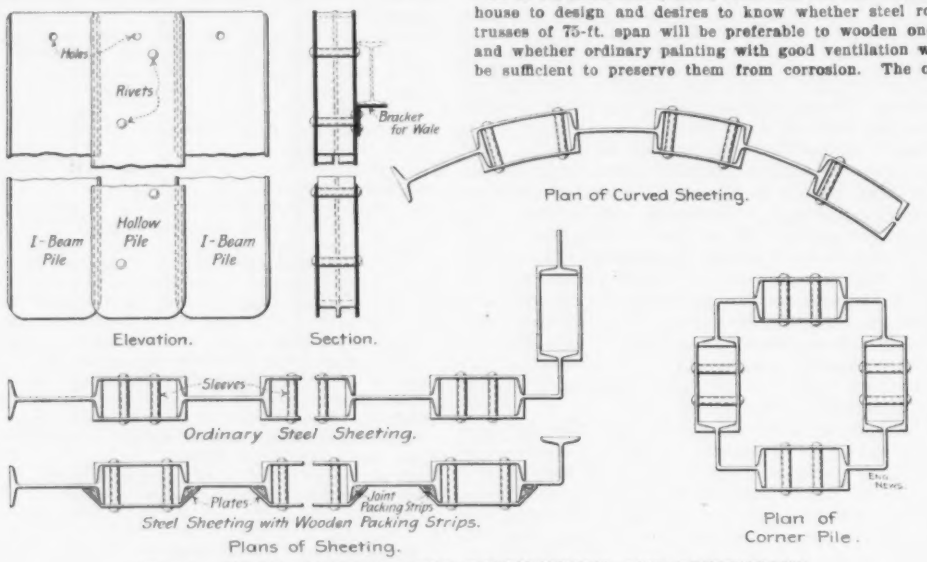


FIG. 1.—METAL SHEETING FOR FOUNDATIONS AND COFFERDAMS.
George W. Jackson, Inventor.

### METAL SHEET PILING FOR FOUNDATIONS AND COFFERDAMS.

In marine foundation works one of the most troublesome features is the construction of a substantial sheathing or cofferdam at reasonable expense, and this difficulty increases with the depth of the work and the pressure of water. Timber sheeting is difficult to drive in certain soils, especially in compact gravel, and is liable to be broken or distorted in driving, so as to impair its watertight properties. The accompanying illustrations represent a form of steel sheeting which may be adopted under various conditions, and which is believed to have special advantages in ease and rapidity of construction, safety, efficiency, and reasonable cost, combined with a considerable salvage value. It consists of two forms of piles, used alternately; the first consists of an ordinary steel I-beam of any desired size; the second consists of two steel channels of corresponding size, set face to face and riveted together, spacing or distance sleeves giving the required clearance between the flanges.

As will be seen from the accompanying cuts, the flanges of the I-beams fit into the ends of the hollow piles, the latter being filled with clay for temporary work, or with concrete for permanent work. The lower edges of the beams and channels are slightly rounded to form cutting edges. Corner piles are formed of I-beams bent at right angles along the center of the web. For curved sheeting, as at bridge piers, etc., the piles may be curved to the desired radius. Where special security against the entrance of water is desired, the outer side of the hollow pile may be formed of a plate with ends inclined inward. When the sheeting is put together, vertical wooden strips are inserted into the pockets thus formed, as shown. Angle irons riveted to the outer face of the hollow piles form seats for I-beam wales.

Fig. 1 shows the general arrangement of the sheeting, and its details, while Fig. 2 shows a design submitted to the North Side Park Commissioners, of Chicago, for the reconstruction of the Lincoln Park sea-wall or bulkhead, parts of which have been undermined and entirely washed away. Owing to the fact that much of this bulkhead is built on made ground, it would be difficult to drive timber sheeting through the mass of stone, brick and other debris. The steel piles, however, would have much greater penetration, and the sheeting could not spread, owing to its interlocked construction. Two designs are shown; one is for a 4-ft. wall with concrete-filled sheeting left permanently in place, the other is for a 6-ft. wall with clay-filled sheeting to be removed after the completion of the work. The material for such sheeting can readily be obtained, as it consists entirely of commercial shapes.

This sheeting has been patented, the designs including a variety of forms built up of shapes and plates, the latter having the edges bent to interlock with those of adjacent plates or to form pockets for the reception of the flanges of I-beams. Another form consists of I-beams set with the bases of their flanges in contact, a T-shaped strip falling over the flanges and being held in place by guides or lugs riveted to the webs of the beams. This system of construction is the invention of Mr. Geo. W. Jackson, consulting and contracting engineer, 756 Rookery Building, Chicago. Mr. Jackson was the contractor for the Strickler tunnel in Colorado, and a 14-ft. concrete subway at Reading, Pa., and is now building a system of concrete-lined telephone tunnels in Chicago.

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### ACCURATE GEODETIC WORK WITH A SMALL TRANSIT.

As many of our readers are aware, a considerable amount of geodetic work for which instruments with large graduated circles were formerly used, is now done with instruments of considerably smaller size. The more accurate workmanship which is now obtainable in engineers' instruments, makes such observations, when carefully conducted, often accurate enough even for geodetic work, and the smaller instruments are much more convenient to carry and set up and less liable to injury and to deformation by careless handling or temperature strains.

As an example of accurate work with an ordinary size engineers' transit, we have been furnished with the data of a test carried out some time ago for Messrs. C. L. Berger & Sons, of Bos-

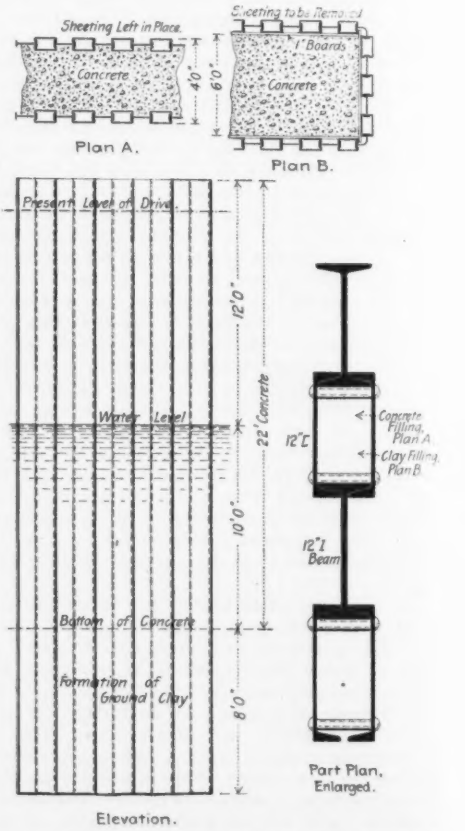



Fig. 2.—Proposed Designs for Lincoln Park Bulkhead, Chicago, with Metal Sheeting.

ton, by Mr. John N. McClintock, C. E., which may be briefly described as follows:

A station was first selected from which were visible five prominent points whose position had been determined by the U. S. Coast & Geodetic Survey. Over this station was set up a Berger 6-in. transit graduated to 30″, and the angles were read successively between each of these points. Each angle was given 12 repetitions, 6 times with the telescope direct and 6 with the telescope reversed. Both verniers were read and the results averaged, and finally when the circle was completed, the resulting angles were found to overrun the circle by 5″. A correction of 1″ was, therefore, made for each angle, this correction being equivalent to a change of only 1 in. in a distance of nearly five miles. Such accurate work with a transit reading only to 30″ is certainly remarkable.

It was next desired to determine the accuracy of the solar attachment, and a computation was, therefore, made to determine the longitude and latitude of the station above noted from the known longitude and latitude of the Coast Survey points named above, and the angles between these points measured as just described. This computation was checked by using different triangles, and the longitude and latitude of the station was thus determined with a probable error of only 1 inch. Observations were then made by Prof. Burton, of the Massachusetts Institute of Technology, to determine the true meridian, using a Berger transit fitted with a solar attachment. The mean of his observations came within 10″ of the true meridian.

## A CURIOUS RESULT OF FIRE ON TIMBER ROOF TRUSSES.

By William Wallace Christie.*

On Nov. 21, 1900, at 4.30 p. m., fire broke out in the old plant of the Ivanhoe Paper Mill, at Paterson, N. J., at the height of a wind storm, the velocity of the wind being 75 miles per hour. The structure, built in 1848, was two-story, brown stone, and the fire, breaking out above the second floor, which was covered with woolen waste, which was being sorted and dried, the floor boards were only burned through in odd places. There remained to be consumed the second story windows and frames and the trussed slate-covered roof.

Eighteen trusses, 48 ft. clear span, spaced 8½ ft. c. to c., carried the roof, which was slate, nailed

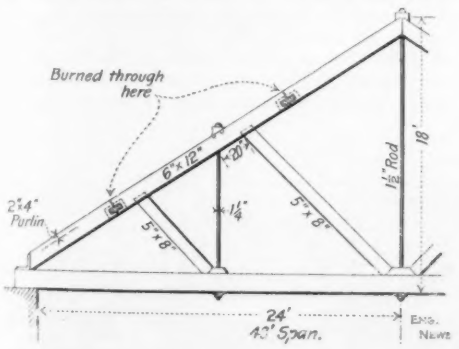



Fig. 1.—Sketch Showing Construction of Timber Roof Truss of Ivanhoe Paper Mill at Paterson, N. J., Destroyed by Fire on Nov. 21, 1900.

to 1-in. boards, nailed to the trusses and intermediate 2 × 4-in. purlins. These 2 × 4-in. purlins were carried at equal distances between the foot and ridge of the trusses on a cross timber about 6 × 8 ins., mortised into the truss, as shown by the sketch, Fig. 1. In the four trusses only which fell, and also in a number of others, which remain in position, the flames ate through the top members of the trusses at this point of mortising. It seems worth while to report this case, as almost all of the roof boards and the 2 × 4-in. purlins were burned off, and the trusses still remained, except four, even though they were weakened as noted. The appearance of one of the burned trusses, which remained standing with the mortise hole burned out, is shown by Fig. 2.

*Paterson Savings Institution Building, Paterson, N. J.

PORTO RICO FRANCHISES have been lately issued as follows: To the Port American Co., New York, to construct and operate a railway belting the island; to Ramon Valdes, giving the right to use the waters of the Rio Plata for generating electricity, and to construct and maintain lines of wires for transmitting electric power for lighting, heating and motive power. The railway may be operated by either steam or electricity; the franchise lasts for 99 years, and not more than 5 cts. per mile can be charged; though this rate can be changed by the executive council. The Valdes franchise gives him control of electric current distribution in the City of San Juan, by paying a royalty to the government.

THE SYDNEY HARBOR BRIDGE DESIGN PRIZE of $5,000, offered to the engineers of the world for the best plans for connecting Sydney, N. S. W., with the North

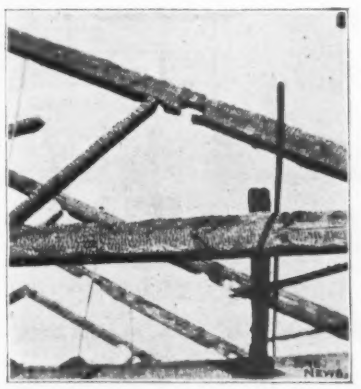


Fig. 2.—View of Burned Roof Truss Showing Weakening of Top Chord by Mortise Hole.

Shore, has been awarded to Mr. E. Cruttwell, of London. The estimates sent in with this plan by Sir William Arrol call for £2,927,236. The second prize of $2,500 was given to Mr. Norman Selfe, of Sydney, who represents a German firm, whose bridge would cost £1,280,000. There were 24 designs and tenders submitted, among these two from the Union Bridge Co., of New York, for a cantilever and a suspension bridge; one from E. S. Shaw, of Boston, for a cantilever bridge, and a suspension bridge plan from E. K. Morse, of Pittsburg, Pa.

A TYPEWRITER in which the power required to operate the printing mechanism is furnished by an electro-magnet has been put upon the market by the Cahill Writing-Machine Co., of Washington, D. C. In general appearance the machine is similar to an ordinary typewriter. The electrical device, consisting of a motor frame, an electro-magnet and a rheostat is placed below the type basket. By depressing a key a pendant is thown over the motor frame and the circuit is closed. This causes the magnet to pull up the motor frame and shove up the pendant. The latter actuates a lever which pulls down a wire, throwing the type bar upward and making the imprint. The circuit is automatically broken and the type bar is free to return independently of the key. The type bar delivers a uniform blow, the strength of which may be changed by adjusting the rheostat. It is said that 20 distinct carbon copies have been made at one time. Only a light touch is necessary and the depression of the key is about one-third that of other machines. Several keys can be depressed in succession without releasing the preceding key and the space is made simultaneously with the last letter of the word. The printing is uniform in clearness, since each bar is actuated by exactly the same amount of force.

## BOOK REVIEWS.

A CATECHISM ON THE COMBUSTION OF COAL AND THE PREVENTION OF SMOKE.—A Practical Treatise for Engineers, Firemen and all others interested in Fuel Economy and the Suppression of Smoke from Stationary Steam-Boiler Furnaces, and from Locomotives. By William M. Barr, M. E. Norman W. Henley & Co., New York. Cloth; 12mo; pp. 350; 85 engravings. $1.50.

There are those who like their books in the form of catechisms, and this one "is the sort of thing they like." It contains the theory and practice of coal burning and smoke prevention doled out in questions and answers. On the whole there is much useful information in the book, and many parts of it will be appreciated by the class for whom it is written. It appears to be largely a revision in a new form of a book on "Combustion and Fuel," written by the same author many years ago, with additions to bring it into line with modern practice. Considerable space is devoted to locomotive furnace details, concerning which the author says in his preface:

There has been a somewhat unlooked for demand for such a book as this, mainly from locomotive engineers and firemen, by reason of the insistance on the part of the management of the more important railway lines that their locomotive engineers and fireman shall, among other requirements, undergo a satisfactory examination in the principles of combustion of coal and of the laws governing the prevention of smoke.

The "single shovel" method of firing is treated at some length and its advantages both in smoke prevention and in improving economy are shown. The well-known mechanical stokers and smoke-preventing furnaces are illustrated. The author is much more at home in his treatment of practical devices and methods than he is in his discussion of theory. In this he is decidedly lacking in clearness, and is sometimes inaccurate. Thus, on p. 58, we learn that an atom is a particle not capable of subdivision, and on p. 59 that a molecule is the smallest possible portion of a substance, whether elementary or compound, which exhibits the characteristic properties of that substance,

and if this molecule be divided its parts are molecules of a different substance or substances from that of which the whole is a molecule. * * In the case of a molecule of an element the atoms are all of one kind. * * As the properties of the molecule of a compound are very different from the properties of the atoms which compose it, so it is probable that the properties of the molecule of an element are different from the properties of the atoms by the union of which the molecule is produced.

On p. 63 we find a new definition of chemical equivalent:

The equivalent is that mass of an element which combines with one atom of hydrogen. In the case of oxygen it corresponds to half an atom, in that of nitrogen to one-third the atom, and in that of carbon to one-fourth the atom.

At the top of p. 52 heat is said to be "invisible energy," and at the bottom of the same page it is spoken of as "a form of visible mechanical energy."

## PROPOSED WATER POLLUTION LEGISLATION IN INDIANA.

Two bills relating to water pollution are before the Indiana legislature. Although the bills are quite different in their plan and scope, they are alike in giving the State Board of Health a large measure of control over water pollution. One bill relates solely to the pollution of running streams by wastes from manufacturing establishments, prohibiting such pollution except under license from the State Board of Health. The other bill relates to all the waters of the State, and all polluters thereof, public or private, but leaves the Board powerless to act until it has "decided that a practical and practicable sanitary method of waste, sewage, or refuse disposal has been discovered, invented, or is otherwise known," and even then the Board can do nothing without an order from a court of jurisdiction in the county in which the pollution exists. To secure such an order, a hearing must be held and the court must be convinced that the method of purification proposed by the Board "is sanitary and both practical and practicable." If the Board succeeds in so convincing the court, then the latter must issue an order for "the construction and maintenance of a sanitary purification plant," the installation to be made within a stipulated time, and the plant to be "installed and conducted according to the approval and rules of the State Board of Health." In case the order of the court is not obeyed

then the responsible parties shall be punished as for a contempt of court, provided, that in the case of a corporation, municipal or private, its officers, or any of them, may be punished by a fine of $500 or by inprisonment not exceeding three months, or by both, or the corporation may be punished by a fine of not more than $5,000.

This second and more elaborate bill provides for a sanitary survey of all the waters of the State, by the Board, and also for the establishment of a well-equipped Laboratory of Hygiene, under the control of the Board and makes an appropriation for the work. It also makes it the duty of the Board

to early endeavor to make practical use of all sanitary data collected as herein provided and to discover, invent or apply proper methods for the construction and conduction of a plant for the sanitary disposal of polluting wastes.

The other bill provides for no sanitary survey and no laboratory and makes no appropriation for carrying on the investigations preliminary to granting licenses for stream pollution to manufacturing establishments. Its plan of action is embodied in the following section, which, aside from the penalty clause of $25 to $500 for violations, is practically the whole bill:

Sec. 2. Whenever any person, firm or corporation, owning or operating a manufacturing establishment, shall file with the Secretary of the State Board of Health a verified application in writing, asking permission to be allowed to discharge into any stream any waste water or refuse from such establishment, and showing therein that the water of said stream is at such a stage as that said refuse or waste water may be safely discharged into such stream without injury to the public, it shall be the duty of such board to inspect the said stream at or below the point of such proposed discharge and if it is found that such refuse and waste water may be safely discharged therein without injury as aforesaid, the said board may, in its discretion,

grant and issue a written permit allowing such discharge into said stream for a time to be limited therein, which permit shall be void and of no effect after the time so fixed, and may be revoked by said board at any time. The holder of any such permit, regularly issued by such board, shall be authorized to discharge any such refuse or waste water into such stream during the time fixed and limited in such permit, and shall not be liable therefor in any suit at law or in equity; Provided, That nothing herein contained shall prevent any person specially damaged by any such discharge from recovering the amount of special damages so sustained in an action at law brought for such purpose.

Both of the bills in question are being opposed by some of the water-works interests of the State and the licensing bill, at least, is opposed by the farmers, who claim to be suffering from pollution due to strawboard and paper mill refuse. The water-works interests, or some of them, claim that no further legislation is needed, the court decisions in the strawboard pollution cases giving them ample protection.

It having been alleged that the State Board of Health, or at least Dr. J. H. Hurty, its secretary, was supporting the proposed legislation in the interests of manufacturing establishments, we addressed an inquiry to him to ascertain the attitude of the Board and its secretary. Dr. Hurty says that the bill for licensing stream pollution is not approved by the Board, but that the other bill is supported by it. After explaining some of the objects of the bill not germane to this article, such as the use of the proposed Laboratory of Hygiene as an aid to the diagnosis of communicable diseases and for the enforcement of the State Food Law, Dr. Hurty continues as follows, under date of Feb. 6:

The third object of the laboratory is to stop the pollution of streams, and, if possible, to save the great industries which pollute the streams. The statutes of Indiana very properly forbid the emptying into streams of any matter whatsoever which will pollute them. Yet in the face of this our Supreme Court has decided that cities and towns have the right to pour sewage in any quantity into the streams. This is an anomalous situation. Tanneries, strawboard factories, tinplate mills, starch works and like industries are not permitted to use the streams for their drainage, but cities and towns are. Of course, you recognize that sewage is the very worst pollution which can be poured into streams. The strawboard works deliver an infusion of straw into the streams. Tinplate mills have a great deal of acid liquor, which is used in stripping the steel plate, preparatory to coating with tin, and the tanneries have their tan liquors. Prosecutions have succeeded against all of these polluting industries, with the result of driving them out of the state. We have thus lost three large strawboard mills and the tinplate works will move if prosecutions continue. A very large tannery at Columbus, Ind., is already taking the preliminary steps to move out of our state on account of prosecutions.

It occurred to us it was possible for science to save these industries and at the same time save the streams. If we had a laboratory we could go to the industries which pollute the streams, secure a sample of their polluting matter, analyze it and afterward advise sanitary methods for its purification. So soon as a method is discovered, which would be both practical and practicable, we could enter the court of the county in which the industry exists, and impose the purification method upon the industry. This would obviously save both industries and streams. We cannot conceive of a better and nobler work which could be done. The importance to Indiana of saving its industries appears from the following figures:

| | |
|---|---|
| Total capital invested in polluting industries. | $20,000,000 |
| Total wages paid annually..... | 5,000,000 |
| Total number of people supported..... | 30,000 |
| Taxes paid..... | several thousands |
| Raw material consumed..... | several millions |

It would be folly to permit suits for damages to drive this capital from the state, provided it can be saved by science through a laboratory without injury to health or property. We have ample rooms in the State House in which to establish a laboratory. We ask for $5,000 for that purpose and $10,000 for the first year to pay the expenses. We anticipate that the first year will not be productive of very great results, because it is plain that twelve months will be a short time in which to get everything running smoothly. We, therefore, ask for no more than $10,000 for the first year, but will want more for succeeding years in order to make the work efficient. I enclose you a copy of the law and also a copy of our circular to the members of the legislature upon the subject.

In closing I have to say that the members of the State Board of Health work entirely without pay, giving freely to the state all their time and their best efforts. Such a body of men would presumably have at heart the best interests of the state in anything that they recommend. All the work they do for the state is done at considerable sacrifice to themselves, both of money and convenience.

Comment on this subject will be found in our editorial columns.

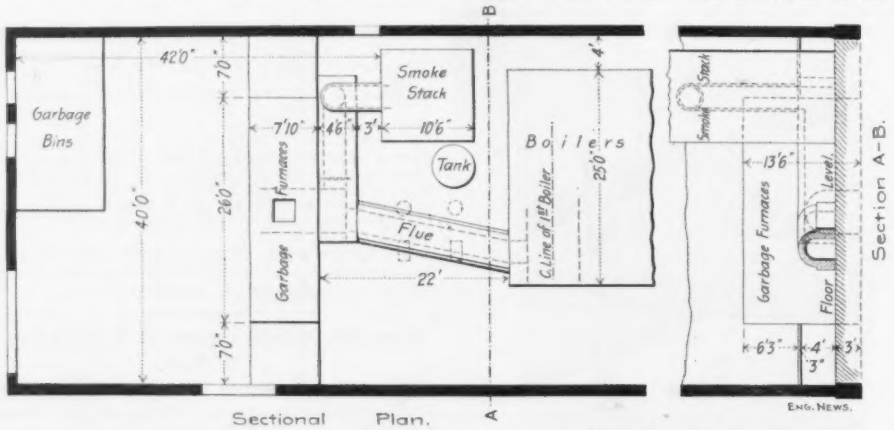



FIG. 1.—GENERAL ARRANGEMENT OF GARBAGE FURNACE AND BOILER PLANT IN CITY ELECTRIC LIGHTING STATION, CHICAGO, ILL.
Edward B. Ellicott, City Electrician; Wright Crematory Co., Contractors for Furnace.

## THE UTILIZATION OF GARBAGE FURNACE HEAT AT ONE OF THE CHICAGO ELECTRIC LIGHT PLANTS.

An interesting practical test is to be made of the possibilities of utilizing heat from a garbage crematory in one of the city electric light plants of Chicago, which, as planned, was to be open early in the present month. The garbage furnace is being built by the Wright Crematory Co., Teutonic Building, Chicago. The company had a furnace in operation at the Chicago Bridewell during the whole of 1900, which, it is stated, was operated at a fuel expense of 10 cts. per ton of refuse consumed, with coal at $3 per ton.

The new furnace is located at one of the old electric lighting stations, which was abandoned awhile ago in order to concentrate the lighting service. There are four boilers in the old station, one of which will be supplied with heat from the garbage furnace, while the others are fired with coal. A sketch plan of a part of the station is shown by Fig. 1, while Fig. 2 shows two sections through the garbage furnace. It will be noticed that the garbage is fed onto an inclined grate, and that there is an extra grate at the front end and above the garbage grate, for a coal fire.

We are indebted to Mr. Edward B. Ellicott, City Electrician of Chicago, for the information given and for the blue prints from which the illustrations have been made. The furnace was built at a nominal price of $1,630.

The collection and disposition of garbage in Chicago is under the direction of Mr. L. E. Mc[illegible]nn, Commissioner of Public Works. In Mr. Mc[illegible]nn's report for the year 1900 he says the methods of disposal employed heretofore

cannot long be continued on account of the scarcity of places that may be utilized for dumping purposes. The installation of garbage disposal crematories of sufficient capacity to destroy all garbage and wastes of the city may be regarded as of the first importance in the consideration of municipal affairs, nor should the system of temporary deposit in wooden garbage boxes be continued. A daily service that will admit of collections being made from portable receptacles before decomposition shall have set in, is necessary to the proper management of this, at best, offensive service.

During the year, 1,528,680 cu. yds. of garbage were removed at a cost of $438,590. This work was all performed by day laborers, paid at the rate of $1.50 per day, and by teams paid at the rate of $3.50 per day. This work has been done more satisfactorily than I have ever known it to be by contractors.

We are informed by Dr. Arthur R. Reynolds, Commissioner of Health, that some citizens separate "their garbage from ashes and other wastes, but the city collects it all in the same wagon." On the questions of separation and also the relative merits of burning garbage and treating it in reduction works, Dr. Reynolds makes some interesting observations, which we have included in an editorial discussion of garbage disposal problems elsewhere in this issue.

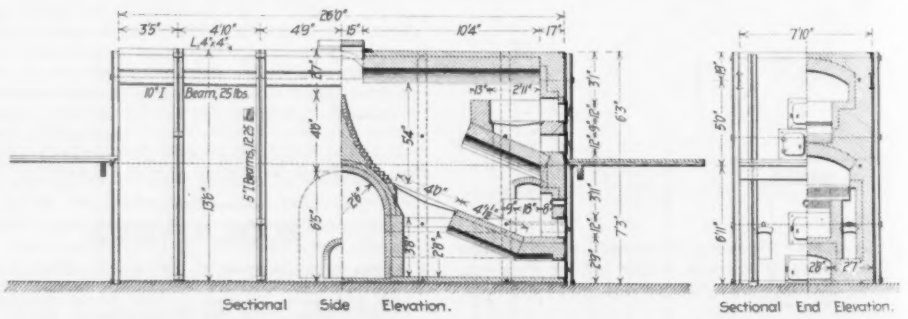



FIG. 2.—SECTIONS THROUGH WRIGHT GARBAGE CREMATORY AT CHICAGO.

## A CO-OPERATIVE TELEPHONE SYSTEM AT GRAND RAPIDS, WIS.

A co-operative telephone system at Grand Rapids, Wis., has been in operation since its installation in 1896, and is described by Prof. A. H. Sanford, of Stevens Point, Wis., in the October number of "The Municipality," a new journal published at Madison, Wis., by the League of Wisconsin Municipalities. When the Wood County Telephone Co., as the co-operative concern is called, was organized, there was an exchange in existence, with about 90 telephones in use, the population then being some 2,000. The old company tried its best to kill the new enterprise by offers of free service for three years and otherwise. Some people accepted this offer, but many of the patrons of the old company became stockholders in the new one. The co-operative company now has a capital stock of $10,000, divided into shares of $50 each. Any person, originally, might become a stockholder by subscribing for one or more shares of stock and renting, for his own use, a corresponding number of instruments. If a shareholder ceases to rent a telephone he is compelled to sell his stock back to the company.

There are now about 300 instruments in use, the population, through natural increase and consolidation of Centralia with Grand Rapids, being estimated at 5,000. The same rates are charged to stockholders as to others, being $2.25 per month for a business house, and $1 for household use, a reduction from the original rates, which were $2.50 and $1.50, respectively. After the first six months of operation a monthly dividend of 1% was declared on stock, and since January, 189[illegible]

notwithstanding the reduction in rates made at that time, the dividends have been 1½% per month, or 18% per year, allowing 6% interest on the actual investment. Shareholders are thus receiving telephone service at a net rate of $24 per year for business and $7 per year for home use, while non-shareholders pay $27 and $12 per year, respectively. The company is now accumulating a surplus at the rate of $100 per month.

No other financial statements are made by Professor Sanford, nor does he say how many of the subscribers have telephones for business use and how many for their homes, nor to what extent the affairs of the company are administered gratuitiously, or at merely nominal figures.

Similar systems, with differences of detail, are said to be in use at Marshfield, Merrill and Wausau, Wis.

## NEW SULPHUR DEPOSITS IN RUSSIA.

By H. L. Geissel.*

At different times works have been erected in Russia for the exploitation of sulphur. The principal one of these was that at Daghestan, in the Northern Caucasus. The largest output occurred in 1888, when it amounted to 1,500 tons, but since then the works have been abandoned. The deposits of Daghestan are, however, very extensive, and yield 20% of sulphur; their geological formation is almost the same as that of the sulphur deposits of the Island of Sicily, which, on an average, yield only from 14 to 17% of sulphur. The chief reason for the abandonment of the exploitation of the Daghestan deposits was their unfavorable situation. At the present time there are in operation in the whole of Russia but two sulphur works, which together produce less than 1,000 tons of sulphur; this equals about 5 to 10% of the quantity consumed in the country. The sulphur deposits which have recently been discovered in Asiatic Russia, namely in Transcaspia, are said to be the second largest in the world. They occur within an area of about 23 square miles, and are situated at a distance of about 100 miles from Khiva, on the Amu-Daria, and 170 miles from Askhabad, on the Transcaspian Railway. Mayeffsky and Konshin, in a recent report, state that the deposits are situated in the immediate neighborhood of the village of Kirkh-Choulba, and that they consist of several groups of hills, extending along the valley of the Ungus; most of the deposits occur in the form of open cuts; the sulphur is mixed with a soft sandstone and yields 60% of pure material.

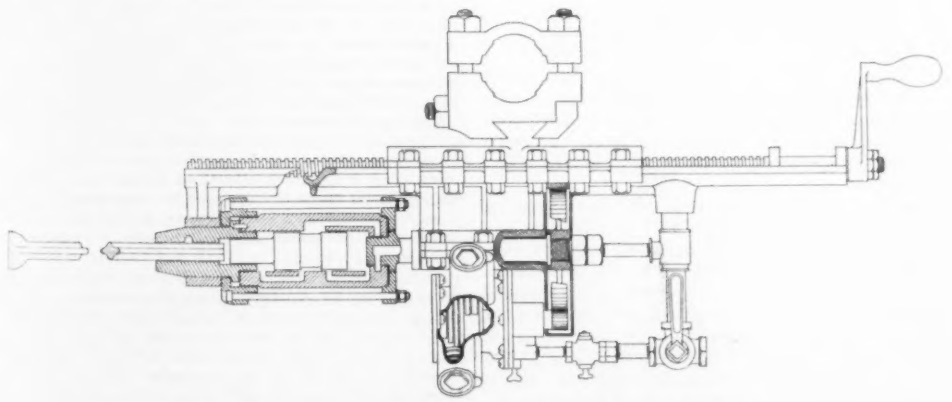


FIG. 2.—SECTIONAL ELEVATION OF PNEUMATIC ROCK DRILL.

No shafts would be required for the exploitation of these deposits. The above-mentioned Russian experts think that the cost of exploitation would not exceed 15 cts. per ton, and that the smelting would cost no more than one dollar. They further recommend the Patcanoff process for the extraction of the sulphur. Patcanoff estimates the cost of sulphur extraction at $1 per ton, and the cost of transportation and taxes at 5 kopecks (2.6 cts.) each per pood (36 lbs.). Should these statements prove to be correct, there will doubtless be a great future for these districts.

*233 South 4th St., Philadelphia.

## QUICK-ACTING PNEUMATIC ROCK DRILL.

In very many of the pneumatic tools which have been so largely introduced within the past few years, the principle involved is the striking of a series of comparatively light blows at almost incredible speed, instead of the slower and heavier blows of other styles of tools. This principle has been applied with marked success in the rock drill illustrated herewith, which was invented by Mr. A. P. Schmucker, of Denver, Colo., and is being introduced by the Chicago Pneumatic Tool Co., of Chicago and New York. Fig. 1 is a view reproduced from a photograph, and Fig. 2 is a sectional elevation.

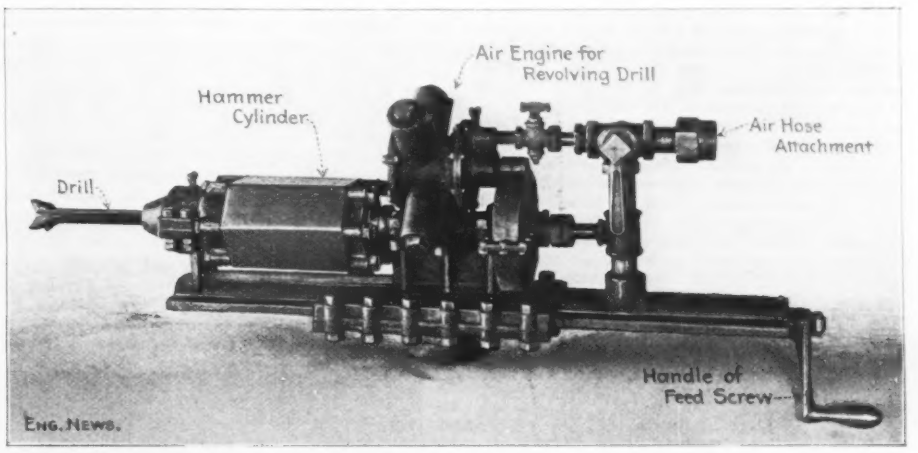



FIG. 1.—THE "CHICAGO-SCHMUCKER" PNEUMATIC ROCK DRILL.

A. P. Schmucker, Inventor. Chicago Pneumatic Tool Co., Makers.

The drill is shown in the horizontal position, but it can be attached to the ordinary column, bar or tripod, and used horizontally, vertically or at any angle. In the hammer cylinder is set a drill bit made of ⅞-in. steel, of any desired length, and having four grooves along its length. It is rolled in this form so that it can be fitted loosely to a chuck shaped to receive it, thus eliminating the use of set-screws, bolts or pins to hold it in place. The drill bit is enclosed in a tube,* on the outside of which is formed a spiral steel thread which is attached to and revolves with the bit, acting as a conveyor to remove the chips and debris from the hole. Owing to the comparative lightness of the blows delivered, the drill bit can be made of the hardest steel with little danger of fracture. The water attachment is a brass casting, the upper end of which is fitted to the grooved bit. In the center is a connection for the water, and at the bottom is a steel tube extending the entire length of the bit, so that the water follows the grooves to the head of the drill.

The drill rod or bit is independent of the hammer and has no reciprocating motion, but simply receives an incessant shower of sharp blows from the hammer. The lightness of the reciprocating parts materially reduces the load on the machine, especially with a long and heavy rod in a deep hole. While receiving these blows, the rod is revolved by gearing driven by a four-cylinder pneumatic engine behind the hammer cylinder. The hammer strikes 4,000 blows per minute, the length of the stroke being 1¾ ins. The engine revolves the drill at the same time at a speed of 125 revolutions per minute. In the hammer cylinder and in the engine the air is used expansively, thereby effecting a considerable economy in air and consequently in cost of operation. The air consumption of the large machines is about 34 cu. ft. per minute. The ordinary form of rock drill usually delivers about 280 blows per minute, requires nearly twice as much air and the length of the stroke is 6 to 9 ins. The weight of the Schmucker drill is only about 95 lbs., (exclusive of tripod, weights, etc.), and owing to its construction the recoil is very light, so that when used on a tripod no weights are required on the tripod legs. It is operated by one man, who can shift it and set it up without assistance. The feed is operated by sliding the machine along its frame by means of a hand crank and feed screw in the usual way.

A number of these drills have been used in mining work, and some have been supplied to the contractors for the New York Rapid Transit Railway. In the Matoa mine at Cripple Creek, Colo., the cost of driving drifts 4½ × 7 ft. is given by Mr. Reynolds, the manager, as $4 per lin. ft. with ordinary drills and $1.35 with the new pneumatic drill, while the monthly cost of replacing worn or broken parts is 80% less with the latter than with the former. It is stated that in a test at the Cashier mine, at Breckenridge, Colo., working in a formation of iron sulphide filled with crystal cavities, this machine drilled 135 lin. ft. of hole during an 8-hour shift, while a Leyner drill made 67 ft. and a Sullivan drill 33 ft. in the same time. Holes 1⅞ ins. diameter have been drilled in hard granite with a "Chicago-Schmucker" drill at the rate of 3 ins. per minute, and in softer rock at 12 ins. per minute. A photograph of the bottom of a hole drilled in hard rock, shows a great number of closely spaced diametrical cuts made by the drill, each stroke cutting off the side of the previous cut.

## THE TESTING OF WINDING ROPES IN THE PROVINCE OF ANHALT, GERMANY.*

By Frank H. Probert, A. R. S. M.

The mining laws relating to winding ropes in some of the German provinces are very strict, and severe tests have to be periodically made to see that the ropes in use come up to the prescribed standard. Permission must be given by the Inspector of Mines to put up a winding plant; and previous to installation a full report made by the manager, clearly setting forth all details of the shaft, the pit-head, engines and appliances appertaining thereto has to be sent to the mining officials. Accompanying each sub-

*From a paper read before the American Institute of Mining Engineers.

sequent report, further details, such as the name of the firm supplying the rope, construction, quality of steel, date of installment, weight per meter, length, particulars of the safety-catches, cages, etc., must be given. At least one spare rope must be kept at every shaft ready for use in case of emergency.

The rope must hang in the shaft, with cage attached, not less than twenty-four hourse before it is used for winding; and it must have undergone a severe test in the manner hereafter described. The laws prescribe that when a rope is continually in use it must be tested every three months; but if the rope is only used every few days it must be tested at least every six months, in the presence of the superior officer; and notification of the date of testing has to be sent to the Gergrath two days before the test is made, in order that he can personally superintend the operation if he chooses. Should winding have been stopped for a long time, it is not necessary to test every six months; but before the rope can be used again it must be tested.

Every two weeks the shaft must be thoroughly examined by the underground foreman, to see that the runners are in good order, while at the same time another man allows the rope to pass slowly and loosely through the hand, to see that no wires are broken. A special book is kept, to be signed by those carrying out these fortnightly tests.

For the other tests, a length of not less than 3 meters is cut off from the cage-end of the rope. This 3 meters is reckoned from the top of the safety-clutch, so that, counting that part of the rope which forms the splice, from 3½ to 4 meters are usually cut off. The one meter above the splice is that selected for the test. The meter chosen is untwisted and thoroughly cleaned, to remove the grease with which the winding ropes are smeared. The central core and the small cores of each strand are laid on one side and not tested. Each individual strand has to be kept separate, and the wires making up the strands are all numbered. The flexibility and the tensile strength of each wire is determined.

To find the breaking weight, a rough testing machine is used. One strand is taken at a time, and each wire of it is proved before another strand is touched. The wires are taken in order, and tightly clamped between clips, which, being about 70 cm. apart, leave a length of 30 cm. to be tested for flexibility. Successive weights of 1 lb. are put into the scale-pan, time being allowed for the stretching of the wire. Sufficient weights are added to break the wire, and the fracture is examined with a hand lens, to see that no flaw exists.

That part of the wire which has not been submitted to the strain is now tested to determine its flexibility. A small hand machine is used for this purpose. The wire is tightly clamped between the jaws of a vise. Three upper edges of the jaws of the vise has a radius of 5 mm. The wire is then bent back and forth through an arc of 90°. This must be done without jerking until the wire breaks—the number of turns being noted. From the vertical, through 90° and back to the vertical, counts as one turn. In this way every wire is tested.

Wires up to 2.0 mm. in diameter must be able to stand 8 turns before breaking; wires from 2.0 to 2.2 mm., 7 turns; from 2.2 to 2.5 mm., 6 turns; from 2.5 to 2.8 mm., 5 turns; and then of 2.8 and upwards, 4 turns.

The tests being finished, the results are tabulated. The weights in kilogrammes are added together and divided by the number of wires. This total is diminished by 20%, and any wire that cannot bear the strain equal to the weight thus obtained is not included in the calculation. Also, any wire that cannot stand the number of turns prescribed for it is thrown out.

When one rope is used for hoisting both men and mineral, two things have to be determined: (1) the relation between the tensile strength and the strain that is usually put upon the rope when hoisting men, and (2) the same relation when hoisting products. For these purposes, a fair average is taken of the weight of four men—the number usually carried in one cage—and also that of a wagon full of ore. To this is added the weight of the rope, cage and safety appliances. The total is divided into the sum obtained above, and we thus establish a ratio between the actual strain the rope will bear and the strain the rope is always submitted to when winding. This ratio must not be less than 6 to 1. Should it fall below that, the rope is condemned.

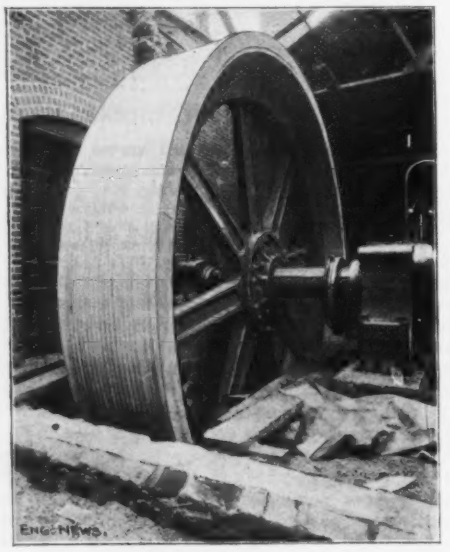
No rope is allowed to be used for more than three years, no matter how good it may be after the lapse of this time, unless special permission is obtained from the Chief Inspector of Mines.

## WOODEN LAGGING FOR ENGINE FLYWHEELS.

One of the features of the machinery trade at the present time is the extensive business done in second-hand steam engines and the very general use of such engines. Good engines may be obtained in this way at a very low price, while immediate delivery is often a point of special advantage to the purchaser. One difficulty which is met with, however, is in the flywheel or driving pulley. Every engine has some sort of wheel, but this may not be suitable for the purchaser's requirements, in which case a proper wheel must be provided. The usual plan is to order a wheel of the desired size from a machine shop, and have it turned for belt or rope transmission as required, giving the old wheel in part payment for the new one.

A cheaper and quicker plan, however, which has been adopted in several cases is to apply a new rim of wooden lagging upon the iron rim of the old wheel. The rims are built up of hardwood strips, powerful presses and special patented machinery being employed in their manufacture. After the rim is completed, the inside is turned to fit the wheel to which it is to be applied. It is then fitted and attached to the wheel, and its face is either turned for belt transmission or grooved for rope transmission, as required. This work is done in a short time, and at small expense as compared with the cost of new wheels. These wooden rims are made by the Dodge Mfg. Co., of Mishawka, Ind., under its patents, and are similar to its wooden-rimmed pulleys (Eng. News, Oct. 11, 1900).

The wooden rims are applicable also for changing a belt drive to a rope drive, or vice versa; for converting a narrow-rimmed flywheel into a power transmission wheel; or for widening the rim of a pulley to enable a wider belt, two belts or more ropes to be used. The lagging increases the effective diameter of the wheel, so that the linear velocity is increased, while the number of revolutions remains unchanged. The greater coefficient of friction or greater driving power of the wood surface as compared with iron, is also an advantage.




Hardwood Lagging for Engine Flywheel.
Dodge Mfg. Co., Makers.

The accompanying illustration represents a lagged flywheel in the paper mill of the Dells Paper & Pulp Co., at Eau Claire, Wis. In order to provide against possible failure of the water supply which operates its power plant, the company decided to install a steam plant, and purchased a second-hand engine which has an 18-ft. balance wheel with a 15-in. flat rim, and weighing 50,000 lbs. As the wheel was not suitable for rope transmission purposes, it was necessary either to secure a new driving pulley or lag the old one. A comparison of the cost of a new pulley and of lagging the old wheel showed that a saving of about 50% would be effected by adopting the latter plan, and a contract was accordingly given to the Dodge Mfg. Co. This lagging is 44 ins. wide, being grooved for 18 ropes, 1½ ins. diameter, and is capable of transmitting 750 HP. The internal diameter is 18 ft., while the pitch diameter of ropes is 19 ft.

At the power plant of the Citizens' Traction Co., of Oshkosh, Wis., it was desired to transmit greater power than the old iron band wheel would allow. This was accomplished by the application of the wooden lagging, which widened the face of the driving wheel and, with the attending increase in diameter and the superior tractive qualities of the wood surface over the iron, secured a material increase in the amount of power transmitted. The internal diameter of this lagging was 16 ft.; outside, 17 ft.; width of face, 17 ins.

At the works of the Thos. Forman Co., at Petoskey, Mich., the hardwood lagging has been used to convert a belt transmission into a rope drive. In 1899, when the plant was remodeled, it was found necessary to change the line shafting and place this at right angles to the engine shaft, instead of parallel with it as before. It was also necessary to drive a counter shaft at each end of the mill in opposite directions. This was accomplished by the application of the lagging to the engine flywheel, using four of the twelve 1¼-in. ropes from the flywheel (with a quarter twist), to drive the shaft at one end of the mill. The other eight ropes, with a quarter twist in the opposite direction, drive the heavier machinery at the other end of the mill. To have accomplished this with belting would have required some very heavy and expensive right-angle belts, taking up much valuable space, and involving considerable expense for maintenance. A hardwood rim made for F. & F. Corbin, of New Britain, Conn., has an internal diameter of 14 ft., with 15 ft. pitch diameter for the 18 ropes, 1½ ins. diameter. This firm desired to transmit power from one building to another on the opposite side of the street, which was done by applying the grooved wooden rim to the engine flywheel and running the ropes through a tunnel under the street.

## LOW-LEVEL CONCRETE BRIDGE OVER THE MARY RIVER, MARYBOROUGH, QUEENSLAND.*

By Alfred Barton Brady, M. Inst. C. E.

The old high-level timber bridge, 1,456 ft. in length, erected across the Mary River, Maryborough, in 1874, having been partially destroyed by the abnormal floods which occurred in February, 1893, thus cutting off the means of communication by road between Maryborough and Tinana and the important goldfield of Gympie, it was decided by the Queensland government and the Maryborough Bridge Board to construct a low-level bridge of a permanent character on the downstream side of the old structure, and to take down, and remove from the site, the standing portion of the old timber bridge, the traffic meanwhile being provided for by a steam ferry. A low-level bridge, it was considered, would serve all purposes and would be much safer during floods. It had been amply demonstrated during floods in various parts of the colony that floating logs, trees, and heavy masses of debris are not usually carried downstream in any considerable quantity until bridges built at low levels have become entirely submerged, and then all drift timber can float harmlessly over them. A low-level bridge would also necessarily be so much shorter between the banks—in this instance 843 ft. shorter—and the cost of maintaining the roadway and the bridge generally would be correspondingly reduced. After some time spent in making surveys, taking soundings and borings, and preparing and considering various schemes, the author's design for a concrete bridge was finally approved by the bridge board and the government; tenders were invited, and a contract was let in September, 1894. The author was induced to recommend a concrete bridge, as it ensures a structure of very great strength, almost everlasting in character, and the annual expenditure in maintenance is consequently reduced to a minimum.

NEW BRIDGE.—The dimensions of the new bridge, Fig. 1, are: total length, 613 ft.; waterway between faces of abutments, 595 ft.; width of roadway between curbs, 20 ft. 8 ins.; width between faces of arches, 22 ft. 8 ins. The level of the roadway on the bridge is 12 ft. 6 ins. above high water of ordinary spring tides, when the depth of water at the bridge is 28 ft.; the maximum flood-level, namely, that attained in February, 1893, is 33 ft. above high water. There are eleven concrete spans, or arches, each 50 ft. in the clear, carried upon ten concrete piers in the river and two abutments, Fig. 1. The rise of each arch is 4 ft., or 2-25 of the span; the thickness of concrete at the crown of each arch is 20 ins. at the center of the roadway and 18 ins. at the curbs, the thickness at the haunches along the center line being 5 ft. 8 ins., Figs. 3 and 4.

ABUTMENTS.—The abutments, Figs. 2, are constructed of Portland cement concrete, composed of 5 parts of hard stone broken to a 2-in. gage, 2 parts of clean sharp sand, and 1 part of Portland cement, and are carried upon iron-bark piles shod with 28-lb. wrought-iron shoes driven to a solid foundation, those in the Maryborough abutment to an average depth of 26½ ft., and those in the Tinana

*Abstract of a paper read before the Institution of Civil Engineers of Great Britain.

abutment to an average depth of 29 ft. below low-water level, the piles being spaced 4 ft. 6 ins. apart, c. to c.

PIERS.—Each of the piers is constructed in two rectangular sections or columns below low-water level, arched over between low and high water and then carried up solid to the springing of the arches, Figs. 3 and 4. Each section of the pier foundations is 10 ft. 4 ins. × 5 ft. 6 ins. in horizontal cross-section, and all were sunk to a rock foundation, the maximum depth below high water being 29 ft. 8 ins. The piers have semicircular ends above low water and are battered above the plinth at the rate of 1 in 24, the sides or faces of each pier being battered at the rate of 1 in 48, to a thickness at the impost, or string-course level, of 4 ft. 6 ins., Figs. 3 and 4. The sections about the cutting edge, gaged 4, 1½ and 1, was laid by a diver and carefully packed round the bags to a depth of 4 ft. The remainder of the seal was gaged 5, 2 and 1. After allowing the core to set for 2 or 3 days, or longer if convenient, the water in the shaft was removed by a canvas baler worked from a steam winch. The baler was made of No. 1 canvas, and measured 2 ft. 4 ins. in diameter, and 4 ft. in depth, being provided with strong hoops of 1¾-in. round iron at the top and bottom, covered with leather to prevent chafing and discharged on an average about 3,000 gallons, or about 35 lifts, per hour. The remainder of the concrete core was then laid, carefully packed and rammed, in the dry, to a level of about 8 ft. below the full height of the concrete casing, thus columns of the piers, a railway rail, Vignoles pattern, weighing 60 lbs. per yd., and 20 ft. in length, with suitable cross bars attached, was built into the concrete, Fig. 4.

The matrix for constructing the piers above plinth level was then formed, having framed molds for the circular ends and for the arch connecting the sections or columns, and 1¼-in. pine boards supported on studding for the intermediate flat surfaces, all properly stayed against the false works used in sinking the columns of the piers. The work of laying the concrete, gaged 5, 2 and 1, was commenced immediately the falling tide had left the surface at the plinth level. These surfaces had been previously thoroughly cleaned and picked over, and were well

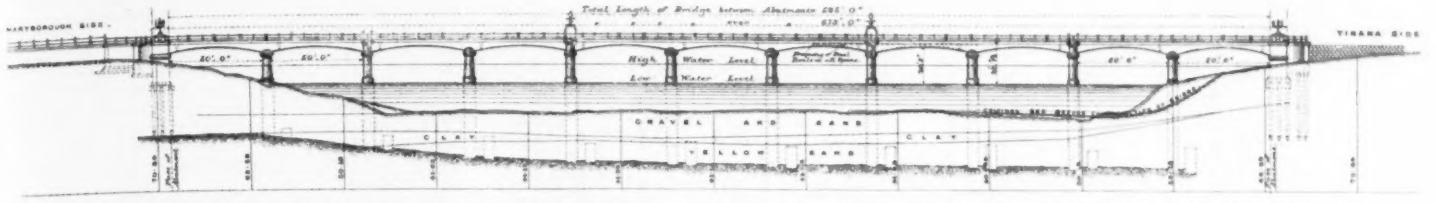



FIG. 1.—PROFILE ELEVATION OF LOW-LEVEL CONCRETE BRIDGE OVER THE MARY RIVER, MARYBOROUGH, AUSTRALIA.

the columns, 20 in number, were sunk by means of wrought-iron caissons. The cutting lengths, 7 ft. long, were formed of external bottom plates, ½-in. thick by 3 ft. wide, and top plates ⅜-in. thick by 4 ft. wide, with an internal pocket formed of ¼-in. plates, 3 ft. 3 ins. wide, having 2 ins. × 2 ins. × ¼-in. angles at the top, Fig. 5. The angle-bars at the joints of the cutting lengths were 2½ ins. × 2½ ins. × ⅜-in., and acted also as stiffeners. The cutting edge was also stiffened with a flat bar, 8 ins. × ⅝-in., double riveted. The intermediate caissons, each 4 ft. in length, were formed of ¼-in. plate, jointed, stiffened and stayed with 2 ins. × 2 ins. × ¼-in. angle-bars throughout, Fig. 6, and were left in place on completion of the work below low-water level. The caissons were designed to be of the least expensive construction possible, all smith-work or forging of angles being avoided, except in the cutting lengths, where the corners were welded. In all other lengths of the caissons, the angles were cut off square, the corners being formed with stiffening pieces of 2 ins. × ½-in. flat iron, and the joints were made up with pine-wood filling. Although this plan was adopted to cheapen the cost of manufacture, it is questionable whether the extra cost of making a superior joint at the corners of the caissons by bending the angle-bars would not have been more satisfactory in the end, as the slight amount of leakage encountered in sinking the piers, at no time exceeding 300 gallons per hour, which evidently came through at the corners, might have been entirely avoided. The slight countersink left in punching the plates was found to be sufficient to hold the plates together, the rivets being simply "nobbled," and the work was practically flush-riveted on the outside, without the necessity for any countersinking of the holes in the plates.

The method adopted in sinking the piers was as follows: A temporary staging of piling, securely braced, was prepared on the site of each pier, Fig. 9; the bottom or cutting length of each caisson was slung to four wrought-iron rods, 2 ins. in diameter, screwed ¾-in. pitch for 10 ft. of their length, and operated by nuts with cross bars having arms of 3 ft. 9 ins. in length, and provided with anti-friction rings underneath. Cement concrete, gaged 5, 2 and 1, was then carefully packed into the pockets and brought up to the top of the caissons, the interior cavity being formed by removable panels of 1¼-in. rough pine, strutted as shown in Fig. 5. The first and second lengths of the intermediate caissons were then bolted on to the top of the cutting length, the joints being made with a chunam of coal-tar and quicklime, and the concrete lining was continued to the top. The caissons were then lowered by "fleeting" the screw hangers, for which purpose strong clamps (a), Fig. 9, were provided, additional caissons being fixed and the concrete lining being continued until the weight was taken on the bed of the river, when divers released the hangers by driving out the bolts securing them to the cutting edge. Sinking then proceeded in the ordinary way by dredging where practicable, but the bulk of the excavation proved to be a tenacious and compact mixture of sand, gravel and clay, with small shells, quite unsuitable for dredging, and removable only by divers. On reaching the rock, the weight of the column, amounting to 60 tons, was again taken on the screws, the suspending rods being transferred to the inside of the column, and a length of each rod being built into the concrete for suspending the column, Fig. 9. The surface was then levelled to a fixed depth gaged below the cutting edge by divers, and the column was finally lowered into position upon bags of fine concrete laid carefully under the cutting edges. Into these the caissons bedded themselves, forming a tight joint to exclude leakage when filling in the concrete core within the column.

The shaft was then sealed by the deposition of concrete through the water in self-releasing skips up to about 10 ft. below the bed of the river at the pier. The concrete forming a key for the upper portion of the concrete pier, Fig. 7.

Some leakage had to be contended with in getting in this portion of the work; the amount, however, was not considerable, averaging between 200 gallons and 300 gallons per hour. By mixing and laying with two full gangs of men, with separate steam derricks to each gang for lowering the concrete, the core was got in with sufficient rapidity to enable the packers to keep well ahead of the leakage, and so prevent the water coming through the surface of the concrete. In one or two instances, when through mismanagement this did occur, considerable difficulty was experienced in removing the water, which accumulated without disturbing the cement. To avoid such a contingency, the resident engineer had a sump formed of ordinary drainage tiles, 10 ins. × 6 ins., of horseshoe shape, laid in the corner of each shaft as the core was brought up, and into this the suction-pipe of a Goold semi-rotary pump was inserted; by this means the level of the water was kept at any time below that at which the concrete was being laid, without disturbing the cement or

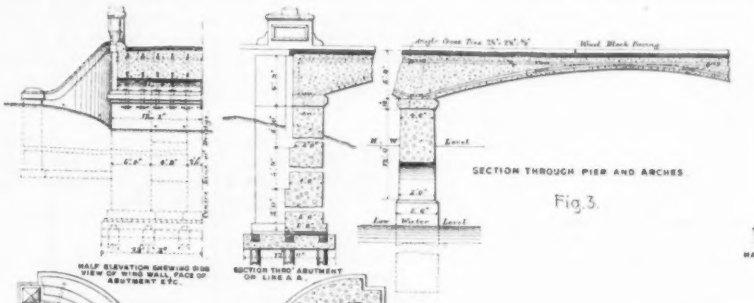

HALF ELEVATION SHEWING SIDE VIEW OF WING WALL, FACE OF ABUTMENT ETC.
SECTION THRO' ABUTMENT ON LINE A A.
SECTION THROUGH PIER AND ARCHES.
HALF CROSS SECTION OF BRIDGE
HALF PLANS OF ABUTMENTS AND WING WALLS. LOOKING DOWN. AT HIGH WATER LEVEL.
SECTION.
ELEVATION.

Fig. 2. Fig. 3. Fig. 4. Fig. 8.

FIGS. 2, 3, 4 AND 8.—SECTIONS SHOWING CON CRETE ARCH CONSTRUCTION; LOW-LEVEL CONCRETE BRIDGE, AUSTRALIA.

interfering with the packers. This sump was carried up to the level of the plinth and was afterwards filled in solid with concrete. The top of each column, forming the plinth of the pier, was laid with 4, 1½ and 1 concrete in temporary iron caissons, similar to the intermediate lengths of the permanent caissons, but having all the angles fixed externally. These temporary caissons were carried up to above high-water mark and were supported by timber shores, Fig. 9. The shores were arranged to be easily knocked out and removed as the concrete reached the top of the plinth of the pier. To provide for any overturning action resulting from the flood pressure upon the face of the bridge producing a tensional stress in the upstream grouted with 1 to 1 compo, to receive the upper concrete work, the first few gages deposited being made richer in cement to secure perfect adhesion. The packing of the concrete was carried on well in advance of the rising tide, to the height of the string course, which was subsequently laid of 4, 1½ and 1 concrete in framed molds. The whole of the concrete in the piers was deposited in self-discharging skips, Figs. 6, worked from a punt on either side of the pier. The temporary wrought-iron caissons, from the river-bed up to low-water level, were by an arrangement with the contractors, left as a permanent protection to the concrete piers. The average pressure upon the foundations, making due allowance for friction and buoyancy, amounts to 4.14 tons per sq. ft.

SUPERSTRUCTURE.—The concrete in the arches or superstructure of the bridge is composed of 4 parts of broken hardstone of 2-in. gage, 1½ part clean sharp river sand, and 1 part of Portland cement. The segmental arches are strengthened by means of a continuous framework formed of steel railway rails, Vignoles pattern, weighing 41¼ lbs. per lin. yd., spaced 2 ft. apart in the arching, Figs. 2, 3, and 4. There are eleven skeleton frames in all, each consisting of two members only, viz.: a horizontal top member, continuous for the entire length of the bridge, and a curved or segmental lower member, following the curvature of the arch in each span, Fig. 3. The frames are bolted to cast-iron chairs or bed-plates on each pier and abutment, and on the latter the chairs are well anchored down to the concrete by long bolts and plates, Fig. 8. There are two cross ties to the framing in each span and one over each pier, each tie being 2½ ins. × 2½ ins. × ⅜-in. iron angle-bar riveted to the flange of the upper member of the skeleton framing, Fig. 3, chiefly for the purpose of stiffening and giving lateral support to the framing during the deposition and ramming of concrete in the arches. The concrete was laid on wood centering, and the steel skeleton framing was completely embedded. The whole surface of concrete exposed to view above low-water level, including soffits of arches, was floated to form a uniform surface, with 1 part of Portland cement to 2 parts of sand laid on in two thicknesses, and finished to not less than ⅝-in. thick; the whole then received a coat of cement-wash, composed of 6 parts of cement to 1 part of sand, mixed fluid in buckets close to where it was required and used immediately afterwards.

In constructing the arches forming the superstructure of the bridge, a considerable amount of forethought had to be exercised to ensure the joints being placed in the positions least detrimental to the ultimate strength of the structure, considered in relation to the flood stresses, as

well as to those resulting from the maximum superimposed load, and also to secure the deposition of the greatest quantity of concrete practicable during daylight—which was not more than 11 hours—as the contractor's arrangements did not admit of continuing work through the night. With this object in view, it was decided to lay a half width of a complete span each day, and this arrangement was adhered to, the whole superstructure being laid in 22 days, with the exception of the parapets, which were built subsequently. To assist the transverse joints between contiguous arches, two cavities, each 4 ft. × 2 ft. 6 ins., were left along the tops of the piers and extending

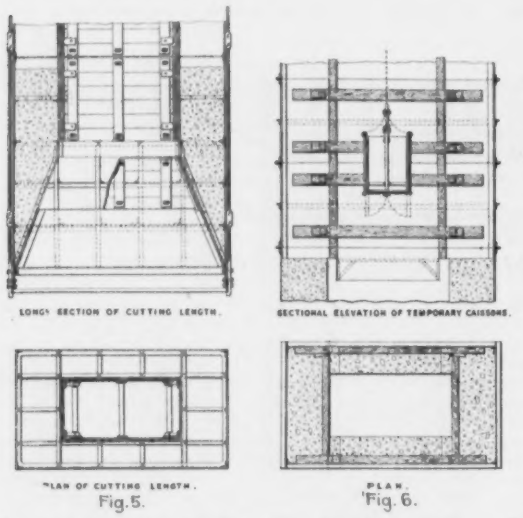



Fig. 5. Fig. 6.

Figs. 5 and 6.—Details of Caisson Foundations for Piers; Low-Level Concrete Bridge, Australia.

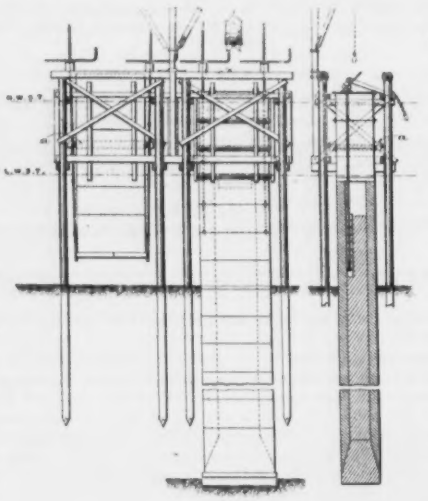



Fig. 9.

Fig. 9.—Details of Staging Used in Sinking Caissons; Low-Level Concrete Bridge, Australia.

the full depth of the haunches of the arch; these cavities were afterwards filled in with a richer concrete gaged 3, 1¼ and 1, forming keys which materially assisted the joint to withstand flood-stresses.

The false works for laying the arches were of pine timber throughout, and consisted of six ribs, 4 ins. thick, in the width of the arch, supported on capsills carried on three piles driven into the river-bed at the center of each span, the outer ends being carried on the staging of the piers. Each rib was 2 ft. deep at the center and 1 ft. at the ends, and was formed of two flitches securely bolted together with ⅝-in. bolts. The ribs were laid with 1½-in. pine planking, wedged at the ends to the required levels, and afterwards securely strutted on to piling. The mold was then completed by the erection of the sides, of 1¼-in. boarding on studding, strutted by longitudinals from the piers to the center capsills, Fig. 7. The whole of the concrete for the arches was gaged 4, 1½ and 1; it was mixed on a large platform, laid on the abutment on the Maryborough side, the stone being carted from a heap 400 yds. away and tipped direct into the gage boxes, and the sand being wheeled from a heap close at hand.

The mixed concrete was conveyed from the platform to the packers in side-delivery tip-wagons running on a temporary tramroad, from which it was discharged on to concrete boards and shovelled therefrom into the work, being well cut in with spades, and rammed solid, a special form of rammer being provided for packing under the bottom rails of the skeleton framing. The concrete was mixed moderately wet, it being found that any excess of water drained off readily through the cleating of the mold, without carrying away cement, the water which escaped being perfectly clear and limpid, whilst the concrete laid better together and could be rammed without difficulty.

As it was thought probable that during floods an upward thrust might be brought to bear upon the arches on the upstream side by trunks of trees or logs of timber becoming jammed under them, a nest of six steel rods, each ⅞-in. in diameter, was built into the concrete across the full span of each arch and parapet curb, along the upstream side of the bridge only, to resist the stresses induced by such an upward thrust, Fig. 10. Steel rail dowels were also used at intervals to connect the concrete parapet curbing to the arching.

The average number of men employed in forming the arches was as follows: Seventeen laborers filling gages and mixing concrete, six laborers filling trucks and running them to four packers and rammers; also four laborers loading stone and sand, six horses and drays with drivers, and one carpenter, or 40 men in all, who mixed and laid, on an average, 11 cu. yds. of concrete per hour.

STONE.—The only cut stone in the bridge is the sandstone coping to the blockings of the papapets at each end of the bridge, the bedstones to the lamp pillars, and the porphyry margin stones to the gully gratings, Fig. 2.

ROADWAY.—The roadway on the bridge was formed of iron-bark block paving, 5 ins. deep, sawn from 9-in. × 3-in. planks. The blocks were coated with boiling tar and were laid with close joints directly on the surface of the concrete superstructure, which was finished with a camber or rise of 2 ins. along the center of the roadway for drainage. The blocks were cut and stacked for seasoning six months before being laid, and after laying, the joints were completely filled and made watertight with a boiling mixture of asphaltum coal tar, and clean sharp grit or river sand. When completed, the whole surface of the wood paving received a thorough coating of well-boiled tar, and was afterwards covered with a layer of sharp sand. Four rows of blocks were laid longitudinally against the curbs on either side of the bridge, the paving between the longitudinal rows being laid transversely. A space or seam, 1½ ins. wide, was left next the curbs, and was filled with mastic to allow for the expansion of the blocks in wet weather. A disastrous flood, however, which occurred in January, 1898, did so much damage to the roadway, washing off about two-thirds of the wood blocking, and the whole of the metalling on the approaches, that it was decided to remove the remaining portion of the wood paving, and to lay the entire length of the bridge and its approaches, a total length of 1,071 ft., with tarred metalling, composed of two parts of hard blue metal broken to a 2-in. gage, two parts to a 1-in. gage, and one part of blue metal screenings or chippings to pass through a ¼-in. mesh, the whole thoroughly dried by heat and then well mixed with boiling coal-tar and stacked to allow the superfluous tar to run off, after which it was spread uniformly, to an average depth of 6 ins., well rammed, brought to an even surface, and then well rolled with a 5-ton roller until thoroughly consolidated, and formed to the proper convexity. The entire area of tarred metalling was afterwards coated uniformly with fine grit sifted from the blue metal screenings. The coal-tar was kept continually boiling for at least 3 hrs. before being mixed with the metal or screenings, and tarred metalling was prepared and laid down during fine weather only. This work was completed satisfactorily in November, 1898. The surface drainage from the roadway on the bridge is provided for by two gully chambers every 54 ft. in the length of the bridge, formed in the concrete of each span, covered with wrought-iron surface gratings in cast-iron frames, protected with hardstone margins, and having outlet pipes, 4 ins. in diameter, through the arches, discharging directly into the river, Fig. 1.

PARAPETS.—The handrailing of the bridge consists of removable wrought-iron stanchions fitted with turned ends into galvanized cast-iron sockets, set in the concrete curbs. Through the forged stanchions pass three rails formed of gas tubing, screwed together at the joints, the two upper tubes being 1¼-in. bore and the lowre tube ¾-in. bore. The parapets are made in sections, four in each span, or 13 ft. 6 ins. in length, having three stanchions in each, for convenience of removal, and with special semi-circular sections on the four intermediate escapes over the piers. It was demonstrated by the resident engineer before the opening of the bridge, that, with the aid of three men, the entire handrailing could be removed in sections, replaced and keyed up again and fixed perfectly right in 3 hrs.; thus showing that, in the case of a sudden rise in the river, no fear need be entertained for the security of the handrailing.

The lighting of the bridge is provided for by four gas-lamps fixed on the upstream side, the end lamps having three lanterns carried on cast-iron standards, and the two intermediate lamps having one lantern each, carried on 3 ins. × 3 ins. × ⅜-in. arched angle-bar standards. The lamps are fixed with special connections, so as to be easily removed in the wet season to leave the surface of the bridge clear for the passage of flood waters over it. Several floods occurred during the construction of the bridge, that on Feb. 17, 1896, rising to a level of 85.39 ft., or within 14.46 ft of the great flood in 1893; and since the completion of the bridge two heavy floods have passed over it, doing no damage whatever to the structure of the bridge, which stood the severe test admirably, the only damage sustained being to the roadway, as already described.

The total cost of the bridge and approaches, including engineering and supervision, amounted to £25,000. The first contractor having failed financially in May, 1895, before much work was done, a second contract for the construction of the bridge had to be let; the successful tenderers were Messrs. McArdle & Thompson of Brisbane, who signed their contract on July 26, 1895, the time allowed for the completion of the work being 15 months. The contractors completed their work within contract time in a highly creditable manner; the bridge being novel in character, and the river subject to frequent floods, the work was not carried through without some difficulties, which, however, were successfully overcome. The bridge was formally opened for traffic with some ceremony on Oct. 30, 1896, by the Hon. David Hay Dalrymple, Minister for Public Works, and the structure was named the Lamington bridge, in honor of His Excellency the Right Hon. Baron Lamington, K. C. M. G., Governor of Queensland.

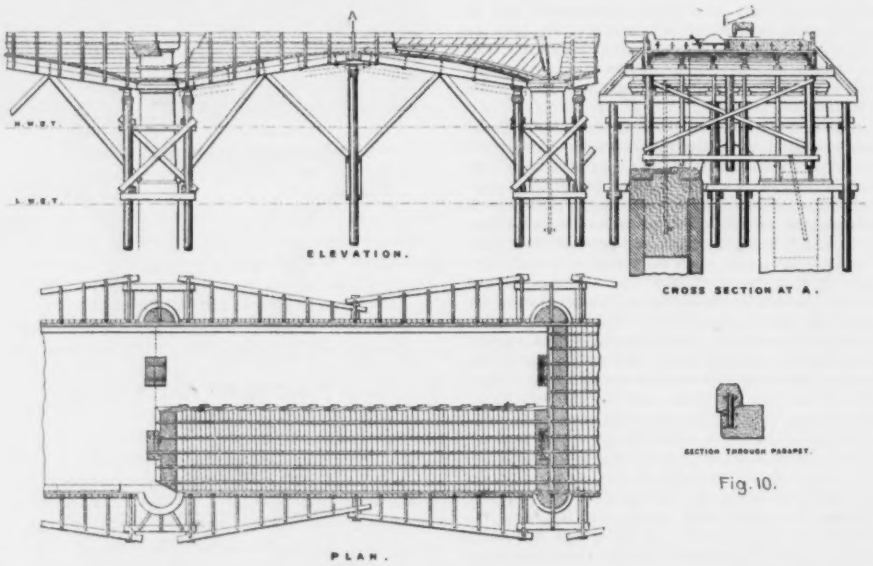



Fig. 7. Fig. 10.

FIGS. 7 AND 10.—DETAILS OF CENTERING FOR ARCH CONSTRUCTION; LOW-LEVEL CONCRETE BRIDGE, AUSTRALIA.

In concluding this paper, the author has much pleasure in acknowledging the able assistance rendered by the Resident Engineer on the works, Mr. Alfred J. Goldsmith, M. Inst. C. E., to whose fertility of resource, engineering skill, painstaking and vigilance, extending over a period of two years, must be attributed in a large measure the successful completion of the structure, the first of its kind in Australia.